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CERTIFICATE

Certified that this thesis "A STUDY OF PIAGETIAN COGNITIVE DEVELOPMENT AND ITS RELATIONSHIP WITH TEACHING EFFECTIVENESS OF PROSPECTIVE SCIENCE TEACHERS" is the product of bonafide research carried out by the candidate, Mr. G.P. UPADHYAYA, under my guidance and supervision, and that it is worthy of consideration for the award of the degree of Doctor of Philosophy in Education.

NVaidya
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CHAPTER I

THE PROBLEM AND ITS SIGNIFICANCE

INTRODUCTION

During the past decade high priority has been assigned to teacher education in many nations of the world. Amidon and Hunter (1966) state that there is a general agreement among educators that teaching needs improvement. Consequently, teacher educators have boldly faced new challenges and introduced several innovations in teacher education. In India too, the need to improve teacher education has been realised. The Secondary Education Commission (1952-1953) dealt with 'Dynamic Methods of Teaching' in detail. The second Indian Year Book of Education (NCERT, 1964) and the Fourth Indian Year Book of Education (NCERT, 1973) have been devoted to the discussion of the development of 'Elementary Education' and 'Secondary Education' respectively. Yet the prevailing picture of the Indian classroom is far from satisfactory. The reason is that the quantitative expension has mercilessly dwarfed the qualitative improvement in education (Jangira, 1979).

The Kothari Education Commission (1964-1966) too has highlighted the need to improve teacher education in these words : "The destiny of India is being shaped in her classroom". The shape, undoubtedly, will depend on what goes on in the classroom and how well it goes on

Earlier researchers like (Anderson et al., 1946; Wispe, 1951; Smith, 1955; Filson, 1957; and Amidon and Flander, 1961) have also underlined the significance of improving teacher education. All this means that the quality of teaching will be determined by quality of teaching behaviour featuring the classroom. Similarly Adawal (1973) and Deve Gowda (1973) comment that the educational benefits that the children of a nation derive depend greatly, if not entirely, on the quality of its teachers. No factor in the teaching-learning process is more important than that of the teacher. Therefore a sound programme of professional education of teachers is essential for the qualitative improvement of education.

Microteaching has been used for several years as a technique for developing skills deemed important for successful teaching. But now, it has been found that teachers who have developed skills through this technique are not always judged to be more effective teachers than others who have not developed these skills (Jangira, 1979). It is so, perhaps, due to two reasons : One being the training in integration of various teaching skills; and the other may be ignorance of Intellectual level of teachers and the training in accordance with it.

Recently after Piagetian Theory, the curriculum framers all over the world have started thinking seriously about the intellectual levels of children for whom they

intend to develop the new curricula. But no care has so far been taken of teachers' Cognitive level. This neglected aspect is essential to know the quality of teaching. The quality of teaching behaviour depends upon the teachers' Cognitive level and level of equipment of teachers with necessary skills in designing and handling teaching behaviour. The studies conducted by Elkind (1962), Towler and Wheatly (1971), Lawson et al., (1975) using Piagetian tasks, reveal that a majority of pre-service science teachers functions at Transitional stage, that is, in between Concrete and Formal Operational Stage.

Although it has been recognized that the teacher exerts a great deal of influence on the pupils, only recently it has been shown that the most important aspects of teacher behaviour, as far as the influence on the pupils is concerned is his classroom behaviour (Flanders, 1960 & 1962). Several researches have been conducted in India and abroad to analyse the teacher's classroom behaviour by using the Flander's Verbal Interaction Technique and other similar systems. These verbal interactions very largely determine the social interaction or social claimate of the class, and it determines in large measure whether the teaching is going to be effective or not. In other words, the optimum teaching effectiveness depends upon what and how interactive phase of teaching goes on in the classroom. But there is a research gap

between the Cognitive Structure of teachers and their verbal behaviour. The research findings give rise to the belief that the teachers at three different levels of cognitive maturity differ in their classroom behaviour.

PERSPECTIVE OF PIAGETIAN THEORY

Jean Piaget, a Swiss psychologist, gave a theoretical and experimental investigation of the qualitative development of intellectual structure. In his studies he found ontogenetic change and developed a highly original theory of intellectual and perceptual development. The Piagetian Theory has been well received by many educators and psychologists with wide application both in cognitive and social development related to all subject areas.

Jean Piaget's cognitive psychology is basically a combination of S-R and Gestalt approach which is the study of the way perception influences behaviour and experience influences perception. It is the study of thought process in the broadest sense (Morris, 1973).

Piaget's work has led to descriptive analysis of basic physical, logical, mathematical and moral concepts from birth to adolescence (Jain, 1982). At heart, his theory is :

(A) a genetic one in that higher processes are seen to evolve from biological mechanisms

which are rooted in the development of an individual's nervous system.

(B) a maturational one because he believes that the processes of concept formation follow an invariant pattern through several clearly definable stages.

(C) a hierarchical one in that the stages he proposes must be experienced and pass through in a given order before any subsequent stages of development are possible.

DEFINITIONS OF KEY TERMS

Some of the key terms used in Piagetian Theory are :

(i) Idea of mental structure
(ii) Cognitive or Intellectual development
(iii) Process of self-regulation
(iv) Concept of operations
(v) Stages of intellectual development

The Idea of Mental Structure

Mental structures are hypothesised "mental blueprints" that guide the organism's behaviour. For example, when a child of around five years of age is shown two sticks (A and B) and asked which of the two is longer, he will have no difficulty in pointing out the longer stick, say stick 'A'. If the child is now shown stick 'B' and stick 'C' and asked which of the two is longer, he will respond by saying that stick 'B' is

longer. If he is then asked about the relative lengths of stick 'A' and stick 'C' without being allowed to see them next to each other, he will be unable to tell which is longer. However, if the same child is given the task at around eight years of age he will be able to conclude correctly that stick 'A' must be longer than stick 'C'. Evidently, something has developed in the child's brain which enabled him to make the correct deduction. Piaget calls that something a mental structure, a hypothesized structure which organizes the environment for him so that he can function successfully with it.

Intellectual Development

The Ontogenetic model of Piaget's cognitive development has been interpreted by some as invariant and immutable under diverse social and cultural stimulation. This view, however, has been denounced by Jean Piaget very clearly as he has assigned the role of four interdependent factors to the development of logical thinking. These four factors are; maturation, experience, social transmission and equilibration, although for Piaget it is via the latter factor that one's actions operate to change his Cognitive organisations.

In this way, the construction of mental structure is a fundamental process in intellectual development. Mental structure provides the basis for our pattern of reasoning

which determines how and what we think and how we interact with our environment. In a real sense our mental structures are reasoning patterns which represent our knowledge about both the physical world and the world of ideas. During cognitive development the growth and change in such processes as learning, language use, concept formation, reasoning and imagining. Such course of development depends both on inner maturation process and on opportunities provided by our environment : specially opportunities for acquiring language, knowledge, and competencies as Bruner (1964) has pointed out :

> "..... the development of human intellectual functioning from infancy to such perfection as it may reach is shaped by a series of technological advances in the use of mind. Growth depends upon the mastery of techniques and cannot be understood without references to such mastery. These techniques are not, in the main, the invention of the individuals who are 'growing up', they are, rather, skills transmitted with varying efficiency and success by the culture-language being a prime example. Cognitive growth then, is in a major way from the outside in a well as from the in-side out".

In short, Piagetian model of intellectual development is based on two additional premises :

1. The succession through the stages of the model is constant. Concrete operational thought

always precedes Formal operational thought.

2. The age at which a particular person enters a particular stage varies from person to person. Further, the average at which children pass through each stage can vary widely from one social setting to another, or from one country to another or even region within a country.

The Process of Self Regulation

A contradiction to present behaviour, or at least awareness that they are not entirely adequate is the first step towards the construction of new mental structure. Piaget calls the process of constructing new mental structure as "Self regulation".

Cognitive development consists of actions which become progressively internalised. Two vital processes : Assimilation and Accommodation are complementary to bring about adaptation and development. Assimilation is the process whereby incoming information is perceived and interpreted in relation to existing schema that he has already established through previous experience. Accommodation is the changing of his inner schema or frame of reference as a result of new information - the structuring or restructuring of his mental organisation.

As a consequence of assimilation and accommodation together with the increasing maturation of the nervous system, the development of thinking involves progressive

change in thought patterns. The thought processes approach a type of stable equilibrium as learning occurs. This can be explained through Piaget's "Assimilation - Accommodation model". On this model, he develops a theory of 'transition', the processes which propels the child through the ontogenetic sequence. This continuous process is one of equilibration. In the interaction of the individual with his environment, the process of assimilation and accommodation get out of balance, producing 'Cognitive conflict' or 'contradiction' forcing the individual into the next stage of development to restore the balance. To resolve this situation, according to Hooper :

> While the locus of this conflict is within the child's thought pattern, the classroom teacher can create mild conflict within the problem setting... In mathematics, for example, alternative method available for obtaining the same problem solution can be presented. As the child is forced to reconcile these distinctive methods to problem solution, he may discover the superordinate rule which subsumes all the methods.

According to Piaget, the process of self-regulation underlies all intellectual development in which construction of new mental structure takes place. Ausubel (1960) has examined this aspect and found that

the cognitive structure is organized by highly generalized concepts under which additional concepts and other information of a more specific nature are subsumed.

Concept of Operation

Piaget discusses the properties of thinking at various age levels in terms of what, 'Operations' children within the age group are capable and incapable of performing. The word 'operation' seems to derive from that of 'action's 'Operation' in the Piaget's sense of the term is a mental action within the person. It modifies that object of knowledge and renders the individual capable of understanding the structure of the transformation that has come about.

In Piaget's view, psychologically, operations are actions which are internalisable, reversible, and co-ordinated into system characterized by laws which apply to the system as a whole. They are actions since they are carried out on objects before being performed on symbols. They are internalizable, since they can also be carried out in thought without losing their original character of action. They are reversible as against simple actions which are irreversible. In this way, the operation of combining can be inverted immediately into the operation of dissociation... Finally, since operations do not exist in isolation, they are connected in the form of structured whole (Piaget & Inhalder, 1961).

Properties of the Operation :

(a) The operation is reversible, it can function in opposite direction.

(b) An operation never takes place in isolation, it is always linked to another system, object or scheme.

(c) The operation is always part of a "structured" and "ensemble". The correct role of operations is to form system, which are "groupings" in the case of qualitative system (simple classification, double entry table, serialised relationships) or "groups" when it is a matter of spatial, temporal, algebraic, geometric, topological structure.

(d) The comprehensive systems are developed according to a certain number of chronological stages, developing in a constant order.

Stages of Intellectual Development

Perhaps Piaget's most notable and significant contribution to contemporary educational thought and practice has been his characterisation of specific intellectual developmental stages.

Piaget views development as an inherent, unalterable, evolutionary process. Within this developmental process he locates a series of distinct development phases and subphases. Piaget had divided the Ontogenetic span into four periods of invariant sequence,

although the chronological age for each may fluctuate considerably. The completion of one stage provides a self-regulation, as well as the beginning of assimilation, for a new stage.

Piaget (1953) has identified these stages as follows :

1. Sensorimotor Stage

It is the first stage of intellectual development which lasts from birth until about 18 months to 2 years of age originally defined by Piaget (1953). This is the stage in which sensory motor performance becomes progressively structured into functional systems which form the building blocks of latter cognitive activity. In this period the child encounters objects by moving and touching without previous thought. A rattle example exists for the sensorimotor child only when he can see it or touch it. The child does not "look for" the rattle as such, but rather comes across it in the course of random sensorimotor motion.

The sensorimotor child behaviour, while organized, is not Cognitive, since it depends on responding to the stimulus as presented, rather than as represented or interpreted by cognitive activity. Thus sensorimotor behaviour lacks the representational component of true cognition (Piaget, 1947). While the elementary school

teachers are not involved directly with children at this stage, psychologists believe that many fundamental, functional learning experiences occur during this period.

2. The pre-operational Stage

It lasts from two to about seven or eight years and it is characterized by the rapid development of representational or 'Semiotic' function which Piaget (Piaget and Inhelder, 1962) considers to develop during the preoperational period - imitation, play, drawing, mental image, memory and languages.

During this period child learns to think, but since he is perceptually oriented (i.e. he is influenced mainly by what he thinks he 'sees' rather than by the operation of any logic), the child commonly lives in an "Alice-in-wonderland" world where apparent visual contradictions do not cause any conflicts in his thinking. This is perhaps best illustrated by Piaget's famous experiment where two identical glasses, each containing the same amount of juice, are placed in front of a five-year-old child. When the liquid from one of the glasses is emptied into a taller but narrower glass, the pre-operational child will indicate that the latter now contains 'more' juice. Since he can focus his attention upon the change in liquid height but cannot simultaneously consider the compensation by the difference in glass diameter, it is clear that the

preoperational child has difficulty in co-ordinating such variables. It is also clear from this experiment that child in the pre-operational stage has not yet developed the concept of conservation.

The pre-operational stage is obviously a time of free play and imagination. It is important, therefore, that teachers of primary classes provide opportunities for the children to engage in play of a perceptive nature, using all of their senses to explore and observe the physical world. In science activities the teacher should be more concerned with having the children touch, taste, smell, listen and watch while discussing these experiences at any length (Anderson et al., 1970).

3. Stage of Concrete Operation

According to Piagetian model, logical thought or operational thought begins to develop at around 7-8 years of age. Although the thinking of the child at this stage (from 7-8 years to 11-12 years) is still concrete (i.e. largely limited to the physical manipulation of objects rather than symbols), he can now perform elementary logical operations. The various reasoning patterns given by Karpulus (1977) are :

C_1 Applies classifications and generalizations based on observable criteria (e.g. consistently distinguishes between acids and bases according to the colour of litmus paper, all dogs are animals, but not all animals are dogs).

C_2 Applies conservation logic - a quantity remains the same if nothing is added or taken away, two equal quantities give equal results if they are subjected to equal change.

C_3 Applies serial ordering and establishes a one-to one correspondence between two observable sets (e.g. small animals have a fast heart-beat while large animals have a slow heart beat).

4. Stage of Formal Operation

The child in this stage (from 11-12 years and continuing through life) has developed the capacity to engage in proportional logic, in other words he is able to manipulate symbols and deal with ideas verbally without the necessity of physical objects. He is now capable of thinking in abstract terms.

The principal difference between the two reasoning patterns is that the concrete operator is confined in his thinking to concrete objects, events or situations. While formal thinker on the other hand, can respond to logical form of argument and deal with preposition, regarding of the specific content involved. Inhelder and Piaget (1958) state "the most prominent feature of formal thought is that it no longer deals with objects directly but with verbal elements". The various reasoning patterns given by Karpulus et al., (1977) are :

F_1 Applies multiple classification, conservation logic, serial ordering and other reasoning

pattern to concepts, abstract properties, axioms and theories.

F_2 Applies combinational reasoning considering all conceivable combinations.

F_3 States and interprets fundamental relationship in mathematical form.

F_4 Recognises the necessity of an experimental design that controls all variables but the one being investigated.

Transitional Stage

Many times we find that a child has attained the concrete stage completely and also attained the formal stage partially, but would not attain the formal stage completely. Such students are classified in transitional stage.

The following five transformations which marked the passage from concrete operational level of thought to the stage of formal operations. In this context, the conditions of transition from the concrete stage to the formal stage, according to Piaget are :

(i) The first and most important transition is the capacity of reasoning on hypotheses. This type of reasoning is called the hypothetico-deductive.

(ii) The second transition is the use of prepositional logic at the concrete operational level. The child is capable of reasoning on what Piaget called "Inter-prepositional logic". He has

become capable of stabilizing the logical link between presage and conclusion independently of the nature.

(iii) The third transformation puts the adolescent pupils in a position to seperate from contents. Which is the logical consequence of the second transformation. Possibilities rather than reality becomes chief distinguishing characteristic of his (adolescent) thought.

(iv) The fourth transformation deals with the combinatorial nature of, that is from the sixteen binary combinatorian to 256 tertiary operation.

(v) The system of all possible combinations forms the logic of preposition whose use and mastery constitute the fifth basic transformation of the formal operational stage of thought.

All these five transformations are derived from one single identifiable mental structure that is the INRC group, where 'I' stand for identify, 'N' for negation, 'R' for reciprocity and 'C' for correlative or dual operation.

CONCEPT OF TEACHING

Gage (1964) has suggested four bases for analysing the concept of teaching.

1. Types of teaching activities
2. Types of educational objectives
3. Components of learning process
4. Families of learning theory

According to the first basis if every thing a teacher does as teacher (e.g. explains, demonstrates, keeps record, makes assignment, plans curriculum) is teaching. Secondly, if teaching is aimed at any of the educational objectives - cognitive, affective and psycho-motor. Then it can be analysed according to the educational objective. Thirdly, if teaching is viewed as a mirror image of learning, then it has components corresponding to those of learning. If learning has components like, 'drive', 'cue', 'response' and 'reward' then corresponding components of teaching might be 'motivation - producing', 'perception - directing', 'response - eliciting' and 'reinforcement - providing'. The fourth way to analyse teaching, not entirely different from those already mentioned, derives from 'families of learning theory'.

Categorization of Definition on Teaching

Different people have viewed teaching from different angles and thus have come out with different definitions. Some have stressed interaction in teaching, whereas others, the restructuring of situations that facilitate learning. In order to understand teaching properly it is desirable to categorize the various definitions on teaching. Four categories used for classification of definitions of teaching are :

1. Teaching in Terms of Teaching Acts :

Gage (1964),"Teaching can be analysed according to type of teacher activities. Teacher engaged in explaining activities, guidance activities, record-keeping activities, assignment making activities, testing and evaluation activities and many other kinds of activities. If everything a teacher does as teacher is teaching activities". Amidon and Hunter (1966) describe teaching as an interactive process primarily involving classroom talk which takes place during certain definable activities. The teaching activities recognized by than are motivating, planing informing, leading discussion, disciplining, councilling and evaluating.

2. Teaching as an Interactive Process :

In the words of Stolurow and Pahel (1963) "....teaching is fundamentally a social process involving communication and interaction between at least two people, a teacher and student". Hughes (1963) defines teaching as "interaction used in its dictionary sense of mutual or reciprocal action or influence". Amidon and Hunter (1966) have described it as an interactive process. Flander (1970) says "Teaching behaviour, by its very nature, exists in a context of social interaction. The acts of teaching lead to reciprocal contacts between the teacher and pupils, and the inter-change itself is called teaching".

Stolurow and Pahel (1963) and Hughes (1963) describe it as an interaction, while Flander (1970) describes it as interactive process. They have emphasised the interaction between the teacher and the pupils. Thus teaching can be understood as an interactive process.

3. Teaching in terms of Restructuring the learning situations :

Thorndike (1913) describes teaching as "..... the arrangement of situations which leads to desirable bonds and make them satisfying". In the words of Gange (1965) teaching is "... arranging the conditions of learning that are external to the learner. These conditions need to be constructed in a stage-by-stage manner, taking the account at each stage of the just previously acquired capabilities of the learner, the requirements for retention of these capabilities, and the specific stimulus situation needed for the next stage of learning".

Skinner (1968) writes, "Teaching is the arrangement of contingencies of reinforcement under which student learns. They learn without teaching in their natural environment, but teachers arrange special contingencies which expedite learning, hastening the appearance of behaviour which would otherwise be acquired slowly or making sure of the appearance of behaviour which might otherwise never occur". In all these definitions emphasis is on creating situations that help learning. Thus

teaching can also be understood in terms of learning situations.

4. Teaching an Interactive Process Leading to Learning

Gage (1963) defines teaching as an "Interpersonal influence aimed at changing the ways in which other persons can or will behave". Quoting a committee of the American educational research, Amidon and Hunder (1966) write that teaching is a form of interpersonal influence aimed at changing the behaviour potential of another person.

Hugh - Duncan (1970) define teaching as "An activity - a unique, professional, rational and humane activity in which one creatively and imaginatively uses himself and his knowledge to promote the learning and welfare of others". Reporting a definition by Morrison, Bhattacharya (1973) writes that teaching is an intimate contact between a more mature personality and a less mature personality which is designed to further the education of the latter. In these definitions the emphasis is on learning through teacher-pupil interaction. Thus teaching can also be understood as an interactive process leading to learning.

Recently Reif, F. et al., (1976) gave the importance of goals of science teaching. He states that "One of the most important goals for teaching science is teaching students to use basic facts and concepts of

science flexibly so that they can deal with new situations, predict various consequences, and solve problems". All these definitions lay emphasis on the teacher behaviour in the classroom in terms of communication.

> "Communication is the exchange of meanings between individuals through a common system of symbols. The text article covers the modern models and theories of communication, the relation of logic and mathematics to communication, non-verbal communication, including signals, signs and symbols and body and gesture language".
>
> - Encyclopedia Britanica,
> Vol.III pp.45.

CONCEPT OF TEACHER BEHAVIOUR

The teaching-learning process is basically dependent upon continuous teacher-taught interaction. It describes classroom interaction in terms of behaviour and emphasises the utility of verbal behaviour in enhancing innovative tendencies and producting effective classroom climate. D.G. Ryans (1970) has tried to explain the concept of teacher behaviour and formulated a theory of teacher behaviour. M.Meux and B.O. Smith have defined the term "Teacher behaviour" as follows :

> "Teacher behaviour consists of those acts that the teacher performs typically in the classroom in order to induce learning".

Similarly, Ryans defined teacher behaviour as :

> "Teacher behaviour may be defined simply as the behaviour, or activities, of persons as they go about doing whatever is required of teacher, particularly those activities which are concerned with the guidance or direction of the learning of others".

THEORY OF TEACHER BEHAVIOUR

Theory of teacher behaviour explains the relationship of variables. There are two important postulates, implied by the above-mentioned straight forward operational definition.

Postulate I : "Teacher behaviour is a social behaviour"

Teacher behaviour concerns with the classroom verbal and non-verbal interaction. In the process of interaction, teacher and students both participate. The initiation and response activities are to be performed by teacher or students. They both influence one another. Therefore, it is considered social behaviour.

Postulate II : "Teacher behaviour is relative"

Teacher's classroom activities are based on social situations. Teacher's activities are the product of social conditions and is relative to the cultural setting in which teacher performs his teaching tasks. Teacher behaviour may be good or bad, effective and

ineffective. This can be judged with reference to a particular culture's value system and set of objectives. Therefore, teacher behaviour is a relative concept.

BASIC ASSUMPTIONS OF A THEORY OF TEACHER BEHAVIOUR

Theory of teacher behaviour is necessarily based on two assumptions :

Assumption I

Teacher behaviour is a function of situational factors, other elements and teacher's personal characteristics. The basic assumption may be summarised in the prepositions that teacher-behaviour is a resultant of (a) certain situational variables, (b) certain organismic conditions and environmental influence and (c) certain pupil characteristics. McDonald (1959) has explained this basic assumption with the help of an equation :

$$TB = F \left[(TV).(PV).(EV) \right]$$

where TB = Teacher behaviour
F = Function
TV = Teacher's variables
PV = Pupils variables
EV = Environmental variables

The basic assumption has following postulates which can be used to predict teacher behaviour :

Postulate I (A) : Teacher behaviour is characterized by degree of consistency.

Postulate I (B) : Teacher behaviour is characterized by a limited number of responses.

Postulate I (C) : Teacher behaviour is always probable rather than certain.

Postulate I (D) : Teacher behaviour is a function of personal characteristics of an individual teacher.

Postulate I (E) : Teacher behaviour is a function of general features of the situation in which it takes place.

Postulate I (F) : Teacher behaviour is a function of the specific situations in which it takes place.

Assumption II

Teacher behaviour is observable :

It is assumed that teacher behaviour may be identified objectively, either direct or indirect observations and provide correlated indexes of teacher behaviour. This assumption is also based on the following postulates :

Postulate II (A) : Teacher behaviours are distinguishable.

Postulate II (B) : Teacher behaviours are classificable quantitatively and qualitatively.

Postulate II (C) : Teacher behaviours are revealed through overt behaviour.

The main purpose of research in teacher-behaviour is to encourage in the beginning for systematic thinking about the teaching process. Teacher behaviour may be of

two types :

1. Verbal Behaviour
2. Non-verbal Behaviour

All activities of teacher which are related to his cognitive aspects constitute the verbal-behaviour of teacher; for example, lecturing, defining, explaining and clarifying. While other verbal behaviours related with emotional aspects are praise, encourage, accept feeling and ideas of the pupils. It is assumed that teaching will be more effective, if teachers start with emotional aspect and leads to cognitive aspect. On the basis of above-mentioned behaviours two types of classroom interaction take place :

1. Verbal Interaction
2. Non-verbal Interaction

It is further assumed that non-verbal interaction is more effective than verbal interaction, but teacher behaviour is highly loaded with verbal behaviour, so most of the interaction in classroom teaching is generated by verbal communication. Hence, verbal interaction very largely determines the social interaction or social climate of the class and it determines in large measure whether the teaching is going to be effective or not.

TAXONOMY OF TEACHER - BEHAVIOUR

The pioneer effort of Ohio State University Research Foundation, Columbus, U.S.A. may duly be recognized

for the development of taxonomy of teacher behaviour. Karl Openshaw and others have tried to develop a taxonomy of teacher behaviour which includes four major dimensions -

1. A Source Dimension
2. A Direction Dimension
3. A Function Dimension, and
4. A Sign Dimension

Each of these dimensions of teaching according to Karl Openshow is observable, quantifiable and their analysis provides empirical evidence about teachers' performative behaviour while teaching is going on.

(i) The source dimension of teaching provides interaction of the relationship of student and teacher at a basic level. Teaching is the interaction between projector entity called teacher and receptor entities within a classroom situation.

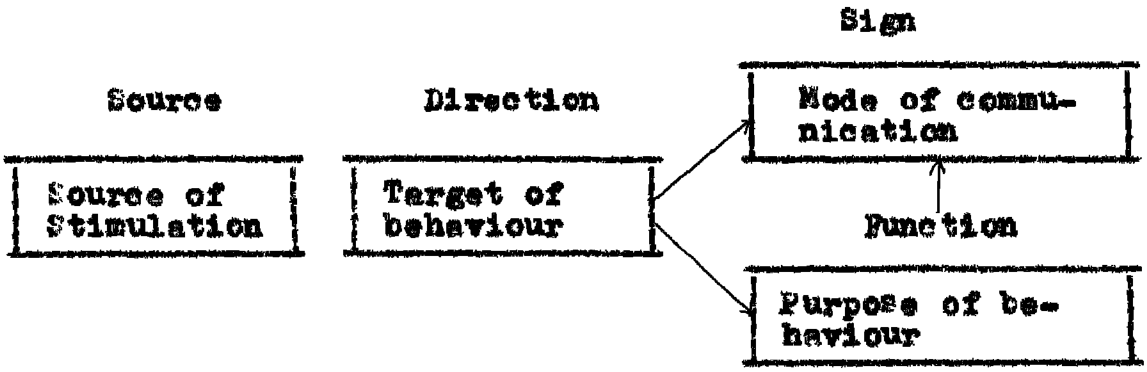
(ii) The identification and classification of the nature of receptor entities provides the direction dimension of teaching.

(iii) The teacher has to perform certain tasks. These tasks (presentation of subject matter) should be dealt with beliefs, attitudes, skills and processes of instruction. The second task is to establish and maintain interpersonal relationship among students in classroom. The third task is to facilitate the learning process. These three tasks constitute the function dimension of teaching.

(iv) Communication of observable behaviour takes several avenues and a given function may require more than one mode of expression in fulfilling a given function. The mode of behaviour makes up the sign dimension of teaching. The diagram illustrating the dimensions of teacher's classroom behaviour is given below :

Fig. 1

Dimensions of Teacher Behaviour



The diagram indicates that the source of behaviour controls other dimensions of teacher-behaviour but it may be determined through the observer's recognition of the target of focus, the direction dimension. The mode of interaction together with the purpose of behaviour gives meaning to all behaviour. Some modes limit the range of possibility of purpose while other purposes may limit the modes behaviour available to the teacher. A given behaviour may be classified in more than one category of the function dimension. Each encounter may have a number of shifts within sign dimension. Any change in the source and direction dimension indicates new encounter.

VARIABLES OF TEACHER BEHAVIOUR

The actions which constitute teaching take place in and are influenced by an environment which typically contains such social factors as mores, organizational structures and cultural resources, as well as physical objects, persons and so forth.

Psychological paradigm, developed by Tolman (1952) illustrates the variables involved in and related to activities constituting teaching falls into three categories :

(i) Independent Variables
(ii) Dependent Variables
(iii) Intervening Variables

It can be seen that actions of teaching belong to the first of these categories, and the actions of pupils to the second. Learning as an achievement is an intervening variable. The index of its presence is pupil behaviour, which itself is a dependent variable .

INTERACTION ANALYSIS : A TECHNIQUE OF ANALYSING TEACHER BEHAVIOUR

One of the important innovations in the classroom teaching-learning is the analysis of classroom interaction of teaching behaviour. This technique of analysing teaching behaviour has been evolved to improve classroom teaching. It provides insight into the nature of classroom

communication and helps in modifying teacher behaviour.

Classroom interaction analysis may be defined as "any system for coding spontaneous verbal communication, arranging the data into a useful display, and then analysing the results in order to study patterns of teaching and learning". Hence, we can say that interaction analysis is a label that refers to any technique for studying the chain of classroom events in such a fashion that each event is taken into consideration. Classroom interaction analysis is particularly concerned with the influence pattern of the teacher which involves encoding and decoding processes of categories. In this way interaction analysis is a technique for capturing quantitative and qualitative dimensions of teachers' verbal behaviour in the classroom, but as an observation system it does not clearly measure all that occurs. Interaction analysis views the dynamics of the classroom through a particular lens. What it captures is the verbal behaviour of teachers and pupils that is directly related to the social-emotional climate of the classroom.

SIGNIFICANCE OF AMIDON AND HUNTER VERBAL INTERACTION CATEGORY SYSTEM (VICS)

Interaction analysis is closely associated with the name of Flanders (1961) who designed the system originally as a part of research into teacher influence and pupil attitude and achievement. The system is concerned

only with verbal behaviour in the classroom and makes an assumption that verbal behaviour is an adequate sample of the person's total behaviour.

Although Ned Flander presents an excellent tool for analysing performance in more concrete terms than has been usual in the past, due to the limitations in FICS later researches have laid emphasis on modification of Flander's system and development of some of the new tools (Amidon and Hunder; 1966;, Richard Ober, 1967; Bentley and Miller, 1970; Verma and Ansari, 1975). In a survey Amidon and Simon (1965) observed that more than 20 systems of classifying verbal classroom interaction are available in educational researches.

In VICS one can code as to what type of questions are asked by the teacher. The modified categories are entered into a 24x24 matrix. Details are given in Chapter III.

Contd.

Amidon and Hunter Verbal Interaction Category System (VICS)

TEACHER TALK	INDIRECT	Response	1. Accepting feeling
			2. (a) Praises (b) Praises using public criteria (c) Praises using private criteria
			3. Accepts ideas through (a) Description (b) Inference (c) Generalization
	DIRECT		4. Asks questions (a) Cognitive memory questions (b) Convergent questions (c) Divergent questions (d) Evaluative questions
		Initiation	5. Lecturing
			6. Give direction
			7. (a) Criticises (b) Criticises using public criteria (c) Criticises using private criteria
PUPIL TALK		Response	8. Pupil response (a) description (b) inference (c) generalisation
		Initiation	9. Pupil initiation (a) description (b) inference (c) generalisation
			10. (a) silence (b) confusion

CRITICAL APPRAISAL OF FICS

Flander's system of interaction analysis suffers from certain limitations. This observational technique has been criticised mainly on the ground that the categories employed in them are ambiguous, that they may occur under such widely different circumstances that the tally cound mean different things in different situation and, therefore, it cannot be regarded as discriminating reliably between classroom. For example, Flanders category 8, "Student talk Response" may occur in such widely different situations as simply a student narrating an interesting anecdote or responding to a simple question, or giving a response involving a higher mental process yet the item would be checked similarly in one kind of situation as another. Similarly, category 4 - "Ask Questions" - would be checked in each situation whenever a question is put without any regard to the quality of question. Although these tallies would be alike, they in fact represent very different behaviours. Under Flander's category 10, "Silence" has been equated with "Confusion". The din of confused ineffective teaching is poles apart from the "Silence" in a class where the students are carefully observing a science demonstration. But the two would be checked similarly.

TEACHERS COGNITIVE LEVEL AND EFFECTIVE TEACHING BEHAVIOUR

In science, teachers are concerned with concepts which are complicated and it is said that "one of the most important goal teaching science is teaching students to use basic facts and concepts of science flexibly so that they can deal with new situations, predict various consequences and solve problems (Hefif, F., et al, 1976).

But these concepts will not be acquired if the logical organization of the concept is more complex than the pupil's logical operation (Raven, 1973). Hence, an essential component of successful teaching is an awareness by the teacher of a pupil level of comprehension, so that a proper match can be made between his level of development and concept learning for effective teaching (Brady, 1970). Bloom (1972) has expressed that it is the teaching, not the teacher that is the key to learning of students. It is a matter of social contact between the educator and the educand, while skills and the materials in the text-book must be mastered to achieve instructional goals. But these do not exist without the interaction between the two. So the teacher's personality is one of the key global variable in teaching situation. Since the teacher is the most influential person in the classroom, his verbal behaviour may directly influence the pupil's verbal behaviour. Such teaching is based on the social interaction

model developed by Flanders (1960, 1963).

It is believed that if the teacher is well aware about the intellectual development and if he is at formal stage, he can redesign the logical structure of an entire concept or part of concept for a student after assessing the cognitive capability of the student for healthy and meaningful interaction conducive to effective teaching. In short it is said that the teacher who is more cognizant of the level of complexity on the concept can best use the child's conceptual development for effective teaching.

CREATIVITY AS A DETERMINANT OF TEACHER BEHAVIOUR

For developing and fostering creativity in young scientists and future citizens, science should be taught creatively. This would be possible if the psychological principles of learning in terms of creativity from the basis of methods and materials of teaching science. Now-a-days, creativity is considered to be an essential characteristic of teachers, who are entrusted with the responsibility of leading children under their charge towards highest achievement. The teacher, who has to work as an organizer of teaching learning process, needs to be creative. In other words, creativity can influence the behaviour of the teacher.

A number of studies have shown positive correlation between measures of creativity and teaching success. Knell

(1953) reported significant correlation between ideational fluency and teaching success. Curtis (1969), Saina (1970), Storm and Larimore (1970), Goyal (1973), all reported positive correlation between creativity and teaching performance. While Torrance (1960), and Yamanat (1964) have shown relationship between creativity and achievement. Hobelman (1957) has described three types of creative teachers :

I. These are brilliant manipulators of children as media for their own creative expression. They require unusual talents and relentless zeal for personal success.

II. These are not always able to inspire. They encourage creativity which comes from the individual's own resources.

III. They are vitally creative in their own right. They are often quite popular, but it does not matter much.

A number of theorists and research scholars hold the view that creativity is the most important human attribute and the key to understand the behaviour of any single person. Therefore, in the present investigation verbal creativity has been used as a determinant of teacher behaviour in respect of the cognitive level of teachers.

SCIENTIFIC ATTITUDE - A SIGNIFICANT DETERMINANT OF TEACHER BEHAVIOUR

The attitude of a teacher is a significant variable

in the classroom which is highly associated with teaching ability. Psychologists have made considerable efforts in this area. Hilgard (1962) has defined attitude as an orientation towards or away from some object or concept or situation, a readiness to respond in a predetermined manner to the object, concept or situation. Allport (1935) has observed that attitude is probably the most distinctive and indispensible concept of social psychology. Attitude may be a crucial part of social role and similar attitudes an aspect of attractiveness (Byrne, 1968). Festinger (1957) and Kiesler (1971) studied the relation between behaviour and attitude concluding that explicit behaviour provides the piller around which cognitive apparatus must be dropped. Through behaviour one is committed.

There is an extensive literature exemplified by the writings of Smith (1947); Levison and Stanford (1950); Osgood and Tannenbaum (1955); Festinger (1957); Kelman (1966); and Stern (1970) in support of the view that attitudes are not isolated personal attributes. Attitudes form broad and coherent patterns which are consistent with, and are an out-growth of deeper personality structure.

Now-a-days attitude research continues to occupy a central position in the process of teaching and learning. In 1934 John Dewey laid emphasis on the development of scientific attitude through formal education. He says, "I do not mean that the responsibility of science cannot

fulfilled by educational method that are chiefly concerned with the self perpetuation of specialized science to the neglect of influencing the much larger number to adopt into the very make-up of their minds those attitudes of openmindedness, intellectual integrity, observation and interest in testing their opinions, beliefs that are characteristic of the scientific attitude."

In the first place, modern educational thought regards the training in scientific method and imparting of the scientific attitude as a fundamental obligation of science teaching. Therefore, it is essential to determine as to what extent our science teachers possess these attributes. It is relevant because it is a science teacher who will further develop these attributes among the students.

The researcher feels that the verbal classroom interaction of a science teacher, who possesses scientific attitude, definitely differs from his counterparts who do not possess scientific attitude. How this teacher behaviour pattern in the classroom is related to scientific attitude and cognitive levels of teachers to teach science effectively is a question to be determined.

STATEMENT OF THE PROBLEM

It was Henry Adams, the historian philosopher who emphatically said, "A good teacher affects eternity; he can never tell where his influence stops". His personality,

his teaching and other forms of interaction with the students are to a great extent responsible for bringing about a change in the student's behaviour. A number of researches have shown that the teacher's classroom behaviour generally decides what is called 'Classroom Climate'. This classroom climate is indeed the measure of his success or failure in teaching and is presumably the resultant of his personality and intellectual growth.

Medley and Mitzed (1963) also substantiated Gage's conclusion that much of the work on teaching effectiveness must be discarded as irrelevent, either because the criteria of teaching effectiveness have been invalid or because no objective measures of teaching behaviour have been used. Thus Schofield and Start (1980) have mentioned that seventyfive years of research on teaching effectiveness have failed to provide us conclusive results for various reasons. One of the most important reasons has been the lack of objective measure of teaching behaviour.

Recently, after Piagetian theory, the educators have started thinking seriously about the intellectual level of teachers. But no adequate attention seems to have been given especially to the teacher's classroom interaction vis-a-vis their cognitive structure. On the other hand, researches have been conducted in India and abroad to analyse the teacher behaviour by using different

verbal classroom interaction systems and also to relate these with various psychological and environmental variables and modification of teacher behaviour. Obviously a research gap is quite apparent in teacher pupil interaction in classroom with respect to cognitive structure of the teacher in the form of presage-process study. So this needs to be thoroughly investigated.

The present investigation should, therefore, highlight the influence of the cognitive factors on classroom behaviour of teachers with regard to creativity and scientific attitude and should contribute towards teaching effectiveness. The title of the study reads as follows :

A STUDY OF PIAGETIAN COGNITIVE DEVELOPMENT
AND ITS RELATIONSHIP WITH TEACHING EFFECTIVENESS
OF PROSPECTIVE SCIENCE TEACHERS

OBJECTIVES OF THE STUDY

In the light of what has been mentioned, the present study aims at integrating the following objectives:

1. To ascertain the level of cognitive maturity, scientific attitude and verbal creativity of prospective science teachers.

2. To study the difference in patterns of teaching behaviour at three levels of cognitive maturity.

3. To study the various behaviour ratios of different scientific attitude teachers at three different levels of cognitive maturity.

4. To study the important behaviour ratios of different verbal creative teachers at three levels of cognitive maturity.

5. To study the mathematical structure of prospective science teachers.

6. To point out the main educational implications regarding teaching patterns and methods of effective teaching based on findings.

HYPOTHESES

Following null hypotheses have been framed to be tested in the study :

1. High - average and low, creative/scientific attitude teachers do not differ in the levels of their cognitive development.

2. No significant difference exists in the pattern of teaching behaviour of pupil teachers at three levels of their cognitive maturity.

3. No significant difference exists in -

   (A) High - average and low creative teachers at Concrete/Transitional/Formal operational level.

   (B) High/average/and low creative teachers at Concrete - Transitional and Formal level.

   With respect to various behaviour ratios (TT; ITT; DTT; PT; S/C; I/D; i/d; PIR; TWR TRR and CCR)

4. No significant difference exists in -

   (A) High - average and low scientific attitude teachers of Concrete/Transitional/and Formal level.

(B) High/average/ and low scientific attitude teachers Concrete - Transitional and Formal level

With respect to various behaviour ratios (TT; ITT; DTT; PT; S/C; I/D; i/d; PIR; TRR; TQR and CCR).

5. No significant difference exists among Concrete, Transitional and Formal level teachers with respect to various behaviour ratios. (TT; ITT; DTT; PT; S/C; I/D; i/d; PIR; TRR; TQR and CCR)

6. Time spent on different categories of Amidon and Hunter's x VICS does not differ with the cognitive maturity of teachers at three different levels.

7. There does not exist mathematical structure in regard to the tests and tools used in the study.

JUSTIFICATION OF THE STUDY

Effective teaching is the focus point of our educational system. The obvious goal of every member of the teaching profession should, therefore, be effective teaching. Unfortunately, despite all that has been spoken and written, we still are hard put to explain what good teaching really is? Teacher effectiveness and teaching effectiveness is defined by different authors in different ways. Good teaching must be defined in terms of the goals of the teaching process and these goals are usually multiple.

Studies related to criteria for selection of effective and ineffective teachers have been numerous, such as those of Barr (1961); Biddle (1964); Rayns (1960); Gage (1970); Fattu (1962); Newsom (1960); Jones (1956); Buchard and Santhanam (1970); Kumlarara (1978); Kaul (1972); Chhaya (Smt.)(1974); Fareeghad Kaw (1971); Mitra (Jr.)(1971); Jangira (1979). These studies seek relationship with one or the other criterion of effectiveness.

Ability to communicate properly is a prerequisite for effective teaching. Hence, it is concerned with those aspects over which it has direct control. Similarly according to some the failure and success of teaching depends upon the interaction which is most important aspect of classroom behaviour of teacher as far as the influence on the pupil is concerned. (Flander, 1960, 1962).

Typically effective teaching has been defined on the basis of external and internal criteria. The external criteria means to judge the teaching made by the teacher not directly in the classroom, while 'internal criteria' refers to behaviours, reactions, and perception of teaching directly involved in the classroom situation.

It is believed that the teacher who is at formal level can interact more successfully than the teacher who is at a lower level of cognitive maturity. The studies conducted by Elkind (1962); Towler and Wheatly (1971);

Lawson et al (1975); Panchaury (1973); Das Gupta W.(1977); Lovell (1971); Chase and Collinson (1962); Randall (1967) reveal that majority of the pre-service secondary science teachers functioned at transitional stage, that is, between concrete and formal operational stages.

The analysis of researches attempted here reflected that not a single study has been tried to establish the relationship between teacher's cognitive levels and their pattern of classroom verbal behaviour or teaching effectiveness. The area, therefore, needs serious concerted efforts to explore further possibilities.

ASSUMPTIONS OF THE STUDY

Before investigation the following assumptions were considered essential :

1. A majority of science teachers do not attain formal operational stage; they are either on concrete or transitional stage.
2. Formal operational teachers do interact more effectively than concrete operational and transitional operational teachers.
3. The verbal behaviour of the teacher is an adequate sample of his total behaviour.
4. Teacher behaviour is observable, distinguishable, classifiable, quantitatively and qualitatively is revealed through overt behaviour and also by symptoms or correlates of behaviour.

5. The classroom verbal behaviour of the teacher is predictable.

6. Teaching effectiveness concerned with the relationship between the characteristics of teachers, teaching acts or verbal interaction pattern, and their effects on the educational outcomes of classroom teaching.

7. Effective teaching can be operationalised in terms of teaching behaviour patterns invariably related to desired educational outcomes.

DELIMITATIONS OF THE STUDY

The study has been delimited with regard to its area, method, sample and statistical technique. The present study has got the following delimitations :

1. It has been confined to one hundred and twenty nine prospective science teachers of various training colleges of Rajasthan.

2. Cognitive levels of the prospective teachers were measured by Raven's test of Piaget's logical operation.

3. Scientific attitude and verbal creativity was considered as characteristics of teacher for teaching success.

4. Verbal interaction category system has been used to record verbal interaction. Non-verbal aspects of teacher behaviour have therefore, not been sampled.

Only two lessons of each of the prospective science teachers were observed.

Recording of the classroom teaching behaviour has been conducted by the investigator.

The presence of an observer in the classroom may be disturbing as the teacher and the students do not reveal the actual behaviour, which may be revealed, while observer is not present in the classroom. The analysis of data is delimited to the computation of Pearson's coefficient of correlation, analysis of varience, significant difference between the mean, Chi-square and factor analysis and their interpretation.

It is to be noted that the findings of the esent study suffer from these unavoidable limitations.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

INTRODUCTION

In order to avoid the replication of the findings and to take an advantage for planning and conducting the study, it was considered essential to review the published and unpublished literature, in the area of teacher's cognitive development and teacher behaviour. In short it is a fact that a review of literature helps the investigator in seeing frontier, in that particular area and getting guidance for developing a plan for his own work.

A large number of studies have been conducted in various countries for finding the intellectual level of children and adults using the Piagetian tasks. But very few studies are there for the teacher's cognitive development. On the other hand, research on teacher effectiveness is over half a century old. It is one of the most researched area in educational research. Ryans and Mitzel have given three criteria of teacher's effectiveness :

(i) Presage criteria
(ii) Process criteria
(iii) Product criteria

A number of researches have been conducted in these areas. Some researches have studied measurement and prediction of teacher effectiveness in a general way, some examined specific factors supposed to be related to

effectiveness such as personality traits of teachers, attitudes and values held by them, their moral and job satisfaction and motives for entering the teaching profession and so on. So much of traditional research on teachers and teaching was conducted to identify characteristics of 'Successful' and 'Unsuccessful' teachers. The criteria for selection of effective and ineffective teachers have been numerous. Morsh and Wilder (1952), after reviewing research on teaching effectiveness published between 1900 and 1952 concluded, "No single, specific, observable teacher act has yet been found whose frequency or percentage of occurrence is invariably and significantly correlated with teaching effectiveness".

Salient reasons attributed to the prevalent pessimism plaguing the area may be :

1. Lack of adequate conceptual frame-work.
2. Lack of agrreement on teacher competence.
3. Absence of objectivity and reliable tools to assess the process variable - teaching behaviour.
4. Inadequate methodology.
5. Complexity of problem.

So it appears that the advice of Ackerman (1954) and Medley and Mitzel (1963) regarding the development of reliable and objective tools to observe, record and analyse

effectiveness such as personality traits of teachers, attitudes and values held by them, their moral and job satisfaction and motives for entering the teaching profession and so on. So much of traditional research on teachers and teaching was conducted to identify characteristics of 'Successful' and 'Unsuccessful' teachers. The criteria for selection of effective and ineffective teachers have been numerous. Morsh and Wilder (1952), after reviewing research on teaching effectiveness published between 1900 and 1952 concluded, "No single, specific, observable teacher act has yet been found whose frequency or percentage of occurrence is invariably and significantly correlated with teaching effectiveness".

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4. Inadequate methodology.
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So it appears that the advice of Ackerman (1954) and Medley and Mitzel (1963) regarding the development of reliable and objective tools to observe, record and analyse

teaching behaviour was well taken. Flander's and Simon (1969) reviewing research on teacher effectiveness from 1960 to 1966 stated that significant positive relationship exists between teacher's acceptance and use of ideas and opinions expressed by pupils, on the one hand, and pupil achievement, attitude and other variable, on the other hand.

Hence, the area of teacher behaviour is a new field of study in teaching effectiveness. The present chapter reviews some significant studies in this area. At the end of the chapter, a few statements are made which summarize the main trends in the area.

STUDIES PERTAINING TO INTELLECTUAL DEVELOPMENT OF ADOLESCENTS

S.No.	Name of the authors and year	Title of the Study	Main findings
1.	Chase, D. and Collinsons J.M. (1962)	The Development of Formal Thinking in verbal comprehension	Majority of the adolescents are at the transitional stage in between concrete and formal operational stage.
2.	Elkind, D. (1962)	Quantity conceptions in College students	i) Most of the College students were still at the concrete operational level. ii) Only 58% of them were clear about conservation of volume concept.
3.	Lovell, K. and Butter worth, J.B. (1966)	Abilities underlying the understanding of proportionality.	Majority of the adolescent pupils do not reach the formal operational level.
4.	Yudin, L.W.(1966)	Formal thought in adolescence as a function of intelligence	Even adolescent pupils of average intelligence, contrary to piaget, show concrete thinking behaviour as defined by Piaget. Added age is an important factor in the development of formal thought.
5.	Dale, L.G. (1970)	The Growth of systematic Thinking: Replication and analysis of Piaget's First Chemical Experiment.	Very few adolescents perform at the formal operationa level.

S.No.	Name of the authors and year	Title of the study	Main findings
6.	Karplus, R. and Karplus, E.F. (1970)	Intellectual Development beyond Elementary school I : Deductive Logic.	Only 40% of the group of Physics teachers used formal operations to solve the Island Problem.
7.	Higgins Frank, A and Geite A.J.H.(1971)	Elusiveness of Formal operational Thought.	Normally Adolescents do not reach the formal level of thinking at the age of 16. Even if they reach the formal stage it should be at the age of 19 or 20.
8.	Kohlberg L. and Gilligan, C.(1971)	The Adolescent as a Philosopher- the Discovery of the self in a Post Conventional world.	All normal children attain the concrete operational level but very few, the formal operational level.
9.	Lovell, K. (1971)	Some Problems Associated with Formal Thought and its Assessment.	About two thirds of the population was at transitional level.
10.	Mckinnon, J.W. and Renner, J.W. (1971)	Are colleges concerned with Intellectual Development?	About three fourths of the College freshmen fail to attain formal stage.
11.	Towler, J.O. and Whealthy G.(1971)	Conservation concepts in college students. A Replication and Critique.	Only 61% of them have conceptualization abstract concept of conservation of volume.

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S.No.	Name of the authors and year	Title of the study	Main findings
12.	Dulit (1972)	Adolescent thinking of Piaget: The Formal stage	Among the general population (20-55) about two thirds fail to achieve formal thought.
13.	Lunzer, E.A. Harrison, C. and Davey, M.(1972)	The Four card Problem and the Generality of Formal Reasoning.	Whereas familiarity with the problem influences performance, the incidence of formal operations is quite low in the general population.
14.	Ross, R.J. (1973)	Some ~~xxx~~ empirical parameters of formal thinking	About half of the undergraduates fails to reach the formal level.
15.	Lawson, A.E. (1974)	Relationship of concrete and formal operational science sub-matter and the developmental of the learner.	77% adolescents are below formal operational level.
16.	Lawson A.E. and Renner J.W. (1974)	A quantitative Analysis of Responses to Piagetian Tasks and its Implication for curriculum.	About 22% of the College freshmen operate at formal operational level while 51% and 27% are found at concrete operational and post concrete operational level respectively.
17.	Nordland, F.H.(1974)	A study of levels of concrete and formal reasoning ability in Disadvantaged Junior and Senior High School Science students.	Twenty year old pupils do not reach the formal level, only 13.27% are at formal level while 85.5% were at concrete level.

S.No.	Name of the authors and year	Title of the study	Main findings
18.	Juraschek, W.A.(1975)	The Performance of Prospective teachers on certain Piagetian Tasks.	About half of the elementary school teachers fail to attain formal thought.
19.	Keating, D.P.(1975)	Precocious Cognitive Development at the level of Formal Operations.	Majority of adolescent pupils do not show formal thinking.
20.	Lawson, A.E. and Renner, J.W.(1975)	Relationship of Science sub-matter and Developmental level of Learners.	About two thirds of the adolescent pupils do not operate at the formal level while acquiring abstract scientific concepts.
21.	Renner, J.W. and Lawson, A.E. (1975)	Intellectual Development in Preservice elementary school teachers. An evaluation.	About 70% of preservice science teachers function at transitional stage.
22.	Schwebel, M. (1975)	Formal operations in college freshmen.	About four fifths of them do not show formal thinking on the three Piagetian tasks.
23.	Karplus R. and Arms A.B. (1976)	Implication of Accumulating Data on levels of Intellectual Development.	About two thirds of general population between 13 to 45 hardly show formal thought.
24.	Pachaury, A.C.(1976)	Conservation Concept in Pre-service science teachers.	75% of the prospective science teachers were non-conserver for volume concept (a concept of concrete operational).

S.No.	Name of the authors and year	Title of the study	Main findings
25.	Das Gupta, G.(1977)	Relationship Between Piagetian Logical Thinking, Science Achievement, Cognitive Science Attitudes in Prospective Seconday Science Teachers.	Out of 84 Preservice Science teachers, 3 were at formal level, 54 were at transitional level and 27 were at the concrete level.
26.	Joyce, L.K.(1977)	A Study of Formal Reasoning in Elementary Education Majors.	Between Age 19-22 yrs., 77% teachers were at formal level, 8% were at concrete level and 15% were at transitional level.
27.	Upadhyaya, G.P.(1978)	A study of Intellectual Development and its Relationship with Intelligence and achievement of 11 grade science pupils.	Majority of the 16-year-old do not operate at formal level.
28.	Pachaury, A.C.(1979)	Formal Reasoning in Graduates.	Many adolescents are somewhere at transitional stage in between concrete and formal operational stage.
29.	Pallrand, G.J.(1979)	The transition to formal thought.	Higher age groups beyond adolescence manifest formal thinking abundantly.

S.No.	Name of the authors and year	Title of the study	Main findings
30.	Walker, R.A. et al (1979)	Written Piagetian Tasks Instruments. Its Development and use.	Concrete thinking dominates even at the age of 15 years.
31.	Padmini, M.S.(1982)	The growth of exclusion of variables during Adolescence-A Study.	Many adolescents were still found to operate at the concrete level.
32.	Jain, S.C.(1982)	A Study of the Problem Solving Behaviour in Physics among certain Group of Adolescent Pupils.	35% Adolescents reaches to the formal level.

RESEARCHES ON INTERACTION ANALYSIS

PRESAGE - PROGRESS STUDIES

S.No.	Name of the authors and year	Title of the study	Main findings
1.	Amidon,E. and Anita Simon (1965)	Teacher pupil interaction.	Achievement, perception and classroom climate were apparently related and relationship between teacher personality and teacher behaviour was uncertain.
2.	Flander, N.A.(1965)	Intent, Action and Feed-back: A Preparation for Teaching.	The training programme based on interaction analysis was found to be more effective in producing change in most of the teachers than the conventional programme.
3.	Amidon,E.J. and Evan Powell (1966)	Interaction Analysis as a feedback in Teacher Preparation.	The student teachers who knew interaction analysis talked less, were more indirect in their use of motivating and is controlling behaviours, more indirect in their over-all interaction patterns, used more extended indirect influence, than the student teachers who were not trained in interaction analysis.
4.	Sirk, Suman Anita et al (1966)	Programming Teacher-Pupil Interaction Patterns	Student teachers trained in interaction analysis tend to be

S.No.	Name of the authors and year	Title of the study	Main findings
			more accepting, have more student initiated talk, are less directive, less critical, have more extended student initiated talk and less silence and confusion than the student teachers trained in learning thereby alone.
5.	Zahn, R.D.(1966)	Helping the Beginning Teacher	Personality of the supervisor seems to affect the attitude of the student teachers, method of instruction and supervision used by the supervisor also appears to affect the same.
6.	Giebink,J.W. (1967)	A failure of the Minnesota Teachers Attitude Inventory to relate to Teacher Behaviour.	The main conclusion was that there was no significant relationship between MTAI Scores and observed teacher behaviour.
7.	Hough,J.B. and Ober,R., (1967)	The effect of Training in Interaction Analysis on the verbal Teaching Behaviour of Pre-service Teacher.	Students in the treatment taught interaction analysis were found to use, in their teaching simulations, significantly more verbal behaviours related to higher achievement and more positive student attitudes towards their teachers and school.

S.No.	Name of the authors and year	Title of the study	Main findings
8.	Kirk, Jeffery (1967)	Elementary School student teachers and Interaction Analysis.	Concluded that training in interaction analysis as means of developing indirect teacher influence.
9.	Lohman, E. and et al (1967)	A study of the effect of pre-service training in Interaction Analysis on verbal behaviour of student teachers.	Student teacher trained through interaction analysis used more-indirection analysis, used more-indirect than untrained student teacher even 12 months after training
10.	Meskowitz, G., (1967)	The attitude and teaching patterns of co-operative teachers and student-teachers trained in interaction analysis.	1. Trained co-operating teachers and trained student teachers who worked together, used significantly more indirect teaching pattern, than untrained co-operating teachers and untrained student teachers working together. 2. No significant differences were noted between the attitudes of the trained and untrained cooperating teachers towards their student teachers.
11.	Randall, William Theodore (1969)	The Relationship of Teacher Attitude and verbal behaviour to participation in a	Teachers having more positive attitude towards children were less direct in their verbal behaviour and they presented less

S.No.	Name of the authors and year	Title of the study	Main findings
		workshop utilizing the Instrument for the observation of Teaching Activities.	subject matter. Besides, those who were having less controlling attitude towards children were found to be more indirect in their classroom verbal behaviour.
12.	Buckner, J.W.(Jr.) (1971)	The effects of Training in Interaction Analysis on Teacher Interpersonal behaviour.	The teacher receiving training in FIAS do not differ from others in three interpersonal behaviour i.e. change in empathy, warmth and genuineness.
13.	Quraishi Z.R.(1972)	Personality Attitude and classroom Behaviour of Teachers.	i) Teachers' verbal behaviour in the classroom was realted x in a small measure to their Personality and attitude. ii) Teachers' attitude towards democratic classroom procedure correlated significantly (at .05 level) with I/D and i/d ratios. iii) Sociable traits were found to be the best predictor of Student initiation.
14.	Vijendra (1972)	A study of Relationship between teaching aptitude and Teacher Behaviour at Secondary level.	Teaching aptitude, attitude and teacher behaviour are highly correlated.

S.No.	Name of the authors and year	Title of the study	Main findings
15.	Goel, S., (1973)	An Investigation into, the Relationship between Teachers' Factual knowledge of Teaching Practice and their classroom verbal Interaction.	i) The extrovert teachers have greater interchange in the classroom events than introvert teachers. ii) The extrovert teachers have longer transition from pupil response and initiation to teacher/praise and encourage, acceptance of feeling, while the introvert teachers have high content emphasis.
16.	Sharma, H.(1973)	A Predictive validity study of Academic grades of B.Ed. students and Classroom verbal Interaction.	Teacher behaviour may be significantly predicted with the help of academic grades.
17.	Pachauri, A.(1974)	A study into certain Adjustment Patterns and Pupil Teachers Classroom Interaction at Secondary Level.	i) Teaching aptitude, attitude and teaching behaviour are highly correlated. ii) Teacher behaviour may be significantly predicated with the help of academic grades.
18.	Patel, P.F.(1974)	An Inquiry into Relation-ship between Pupils' Attitudes and Teachers' Influence in the Classroom.	i) Indirect teacher influence had favourable effect on motivation and classroom Organisation and also on the attitude towards teachers.

S.No.	Name of the authors and year	Title of the study	Main findings
			ii) Teacher classroom behaviour did not influence pupil attitude towards reward and punishment. iii) Teacher Classroom behaviour did not influence pupils attitude towards school.
19.	Ryan, J.F. (1974)	The Association of Teacher-Student Personal Relationship and Classroom Interaction.	Found no significant gain in 'Teacher Indirectness' in verbal teaching behaviour of-teachers, received strong in interpersonal relationship as compared to teachers perceived week in interpersonal relationship by their students. However, significant gain in 'The use of Pupil Ideas' was observed.
20.	Singh (Smt), S.k. (1974)	A study of the Relationship between verbal Interaction of Teacher in classroom and Attitude towards teaching.	i) Indirect influence, pupil talk, indirect to direct ratio, pupil initiation ratio, teacher response and question ratios appeared to be significantly related to attitude towards teaching subject, groups and teaching classes. ii) There exists a significant relationship between attitude

S.No.	Name of the authors and year	Title of the study	Main findings
			towards teaching and classroom verbal interaction of student teachers of Secondary level.
21.	George, Matthew (1975)	Classroom Behaviour of teachers and its relationship with Creativity and self-concept.	i) There is no significant relationship between creative teacher personality and indirect or direct behaviour of teacher. ii) There is a positive correlation between creative teacher personality and teacher talk and negative correlation between creative teacher personality and vicious circle. iii) There is no relationship between self-concept of teacher and their indirect/direct behaviour.
22.	Girrets, John Eric., (1975)	An exploratory study of the Teachers' Educational Attitudes and their Classroom Teaching practices.	Significant correlations between extended indirect influence and progressive educational attitude was noticed.

S.No.	Name of the authors and year	Title of the study	Main findings
23.	Jindal(Smt.) R.,(1975)	An experimental study of the modification in classroom behaviour and self-perception of B.Ed.students through the Training in Flanders Verbal Interaction Technique.	i) The finding indicated that the gain in self-perception and classroom performance were significant at 0.10 and 0.01 level of confidence respectively. ii)Significant increase in I/D ratio, TRR, TQR and PIE were noted.
24.	Bhargava,S.C.(1976)	Influence of certain personality variables on classroom interaction of teacher trainees of experimental and control group of R.C.E., Ajmer.	Teacher, low on personality variables, used maximum teacher talk and teacher, high on personality variables, sought more student participation.
25.	Mehta, Y.M.(1976)	An enquiry into the relationship between teachers' classroom communication pattern and certain perceptual factors.	i) Teacher communication is not related with age and sex of teacher. ii) Significant multiple correlation was found in I/D, T/S, TT and ST.
26.	Barnwal,A.P. (1978)	Creativity correlates of teacher behaviour	i) Teachers having more verbal creativity do not encourage students but restricted their participation by giving direction.

S.No.	Name of the authors and year	Title of the study	Main findings
26.			ii) Positive correlation between creative teacher personality and teacher talk and negative correlation with vicious circle were reported.
27.	Shashikala, Y.S. (1978)	A study of Interpersonal Relationship between the teacher and student with a view to establishing Socio-psychological correlates of Teacher Behaviour.	i) Age is positively related to I/D and T.R while negatively to i/d and CCR at 0.01 level of confidence. ii) There is no significant difference in teacher behaviour under different types of climates.
28.	Satya, K. Sharma and et al (1978)	How are our Better Teacher like?	Finding of the study reveal that the teachers talked about 5/8 of the total time, pupil for about 1/8 of the time and none talked for about 2/5 of the total time. All belonging above average level superior level of intelligence.
29.	Singh, Ajit, (1978)	A study of creativity in School teachers as measured by Mehdi's Test of creativity in relation to their classroom verbal interaction.	i) There is a positive and significant relationship between verbal creativity and student talk, indirect/direct behaviour of teachers and their self-concept.

S.No.	Name of the authors and year	Title of the study	Main findings
			ii) There is no significant relationship between verbal creativity in teachers and confusion in classroom verbal creativity in teachers and their convergent questions and indirect/direct attitude towards teaching.
30.	Saran, S.K.(1979)	Effect of Teacher Education Programmes on Self-perception, Classroom Performance and Teaching Behaviour of Regular and Prospective Teachers.	i) Student teachers of the SSCC course and four-year integrated course were rated better in self-concept and classroom performance as compared to one-year B.Ed. group. ii) Trained regular teachers provide lesser opportunity for student participation and initiation.
31.	Jayashree Panda (Kum), (1980)	An experimental study of the change in Attitude, Classroom performance and Verbal behaviour of pre-service science teachers through Feed-back Strategies.	Attitude and classroom performance correlate verbal behaviour of teachers.

S.No.	Name of the authors and year	Title of the study	Main findings
32.	Sharma, A.L.(1982)	A study of the Relationship between Attitude towards teaching and classroom verbal interaction of teachers (with special reference to pre-service commerce teachers).	Attitude towards teaching has got relationship with verbal interaction of teachers.

Key Statements Regarding the Area

The above review of related literature has indicated very few researches have been conducted at Ph.D. level to relate presage variables with process variables. The key statements of the review are given below :

1. The studies conducted by Chase and Collinsons, 1962; Lovell and Worth, 1966; Dale, 1970; Higgins and Gaite, 1971; Kohlberg and Gilligan, 1971; Lawson, 1974; Keating, 1975; Lawson and Renner, 1975; Upadhaya, 1978; Pachaury, 1979; Padmini, 1981; and Jain, 1982 have indicated that a majority of adolescent pupils does not show formal thinking.

2. Elkind, 1962; Karplus and Karplus, 1970; Jurarchek, 1975; Renner and Lawson, 1975; Pachaury, 1976; Das Gupta, 1977; Jayce, 1977 have indicated that a majority of pre-service Secondary Science teachers functioned in between concrete and formal stage i.e. Transitional stage.

3. Studies like Lovell, 1971; Dulit, 1972; Lunzer and Harrison, 1972; Walker, 1979 have mentioned that among the general population about one third fail to achieve formal thought.

4. The relationship between presage variables like teacher personality, self-concept, attitude, sex and age and process variable - the teacher behaviour was found to be uncertain by Amidon and Simon, 1965; Gilbink, 1967; Maskowitz, 1967; Vijendra, 1972; Singh (Smt.) 1974; Gorge Matthew, 1975; Mehta, 1976 and Sharma, 1982.

5. Vijendra, 1972; Goyal, 1973 and Barnwal, 1978 have mentioned positive correlation between creativity and teacher behaviour.

6. The researches conducted by Flander, 1965; Amidon and Powell, 1966; Suman Amita, 1966; Hough and Ober, 1967; Kirk, 1967; Moskowitz, 1967; Quraishi, 1972 and Jindal (Smt.) 1975 have indicated that student teacher trained through interaction analysis used more indirect behaviour.

7. Researcher's Frust, 1967; Pankratz, 1967; Penney, 1969; Weber, 1968, Flander, 1970; Pareek and Rao, 1971 and Pawansam, 1977 have tried to predict teaching success on the basis of teacher verbal behaviour. They mentioned significant positive relationship between indirect teacher behaviour and pupil achievement. This infers that indirect teacher behaviour is conducive to effective teaching.

Difference Between Present Study and the Past Studies

The present investigation differs from others on the following lines :

1. An attempt was made to measure the cognitive maturity of prospective science teachers by Raven's Test of Piagetian cognitive development.

2. Cognitive development, verbal creativity and scientific attitude were considered as presage variables.

3. Attempt was made to underline the relationship among cognitive maturity, scientific attitude and verbal creativity.

4. The teacher classroom behaviour (Process variable) was observed through Amidon and Hunter's verbal interaction category system.

5. Prospective teachers were categorized in concrete, transitional and formal groups, on the basis of cognitive maturity and eleven important behaviour ratios were computed. Teacher Talk (TT); Indirect Teacher Talk (ITT); Direct Teacher Talk (DTT); Pupil Talk (PT); Silence/Confusion (S/C); Indirect to direct Ratio (I/D); Small Indirect to Direct Ratio (i/d); Pupil Initiation Ratio (PIR); Teacher Response Ratio (TRR); Teacher Question Ratio (TQR) and Content Cross Ratio (CCR).

6. Clockwise flow diagrams and Box flow diagrams were prepared for concrete, transitional and formal group, separately to know the difference in verbal behaviour pattern.

7. Attempt was made to know the mathematical structure of science teachers.

CHAPTER III

PROCEDURE AND DESIGN OF THE STUDY

INTRODUCTION

The present chapter embodies the design, methodology and procedure of investigation. It also includes a short description of tools and statistical techniques used.

METHODOLOGY

The study has been conducted through normative testing survey method and the cross-sectional approach has been followed. It was focused to ascertain the relative teaching effectiveness of teachers at three different levels of cognitive maturity, scientific attitudes, verbal creativity and teaching behaviour. In order to explore the verbal behaviour, Verbal Interaction Category System (VICS) developed by Amidon and Hunter (1966) was employed. As a matter of fact, this is an improvement upon Flander's Interaction Analysis Category System.

SAMPLING PROCEDURE

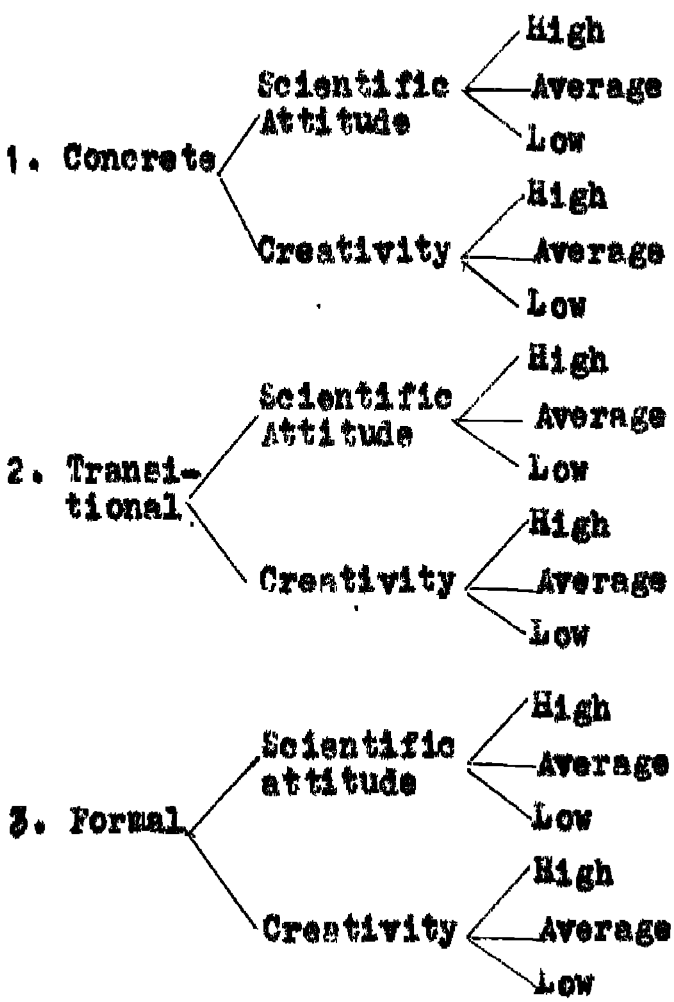
The finding of any research is, of course, dependent upon a sampling procedure. Hence, in sampling it was assumed that it would be the representative of the population. The population in statistical investigation, is arbitrarily defined by its unique properties. According to this concept, in the present study, the population be considered to be composed of all student-teachers offering science subjects for their teaching practice in training colleges of Rajasthan University. Out of two hundred, one hundred

and twenty nine (57 boys 72 girls) subjects were selected through cluster sampling technique as they gave all the tests.

In this investigation Northern region of Rajasthan was chosen, so that proper and real observations could be performed. The professors of these colleges were requested not to tell about interaction analysis to their pupil teachers, except giving one suggestion only i.e. try to avoid lecturing as far as possible. They were further requested not to remark on the note-books of science pupil teachers until the investigator observed their teaching practice. It was also kept in mind that earlier lessons should be observed. In the investigation, mainly the, "correlational" and the "correlational group designs" have been used. The correlationship between the values of one variable and the values of another variable was studied. Further, the group differing in an independent variables are compared with respect to a dependent variable. Comparisons between the groups differing in independent variables like, cognitive maturity, creativity and scientific attitude have been made in correlational fashion. Within each differing group the subjects were relatively homogenous with respect to some variables (independent variables), while it had some comparable values with respect to other differing groups for the same variable. In the correlational group designs these independent variables are also called as

classification variables (Achenbach, 1977). Each classification variable was used to define the dimensions of comparison and was crossed with the scores of dependent variables (Interaction variables). The variables are given below :

__Independent variables__



__Dependent variables__

Teacher Talk (TT)

Direct Teacher Talk (DTT)

Indirect Teacher Talk (ITT)

Pupil Talk (PT)

Silence or Confusion (S/C)

Indirect to Direct Ratio (I/D)

Small indirect to direct ratio (i/d)

Pupil Initiation Ratio (PIR)

Teacher Response Ratio (TRR)

Teacher Question Ratio (TQR)

Content Cross Ratio (CCR)

Table 1

Number of pupil Teachers representing College and Sex Variable

S. No.	Name of College	Boys		Girls		Total	
		Cases	%	Cases	%	Cases	%
1.	Bihani College of Education, Sriganganagar	29	50.88	36	50.00	65	50.39
2.	Dadhi Mathi Teachers Training College, Sriganganagar	17	29.82	21	29.17	38	29.46
3.	Government T. T. College, Bikaner	11	19.30	15	20.83	26	20.15
	Total	57	100	72	100	129	100

Table 1 indicates the number of candidates of selected sample with regard to colleges and sex variables. It is represented by graph 1.

The obtained data for sample have been further analysed with regard to academic qualification of boys and girls separately. It is represented in Table 2 and by graph 2.

Table 2

Academic Status of the Sample

Academic qualifications	Boys		Girls		Total	
	Cases	%	Cases	%	Cases	%
1. Post Graduates	20	35.09	19	26.39	39	30.23
2. Graduates	37	64.91	53	73.61	90	69.77
Total	57	100	72	100	129	100

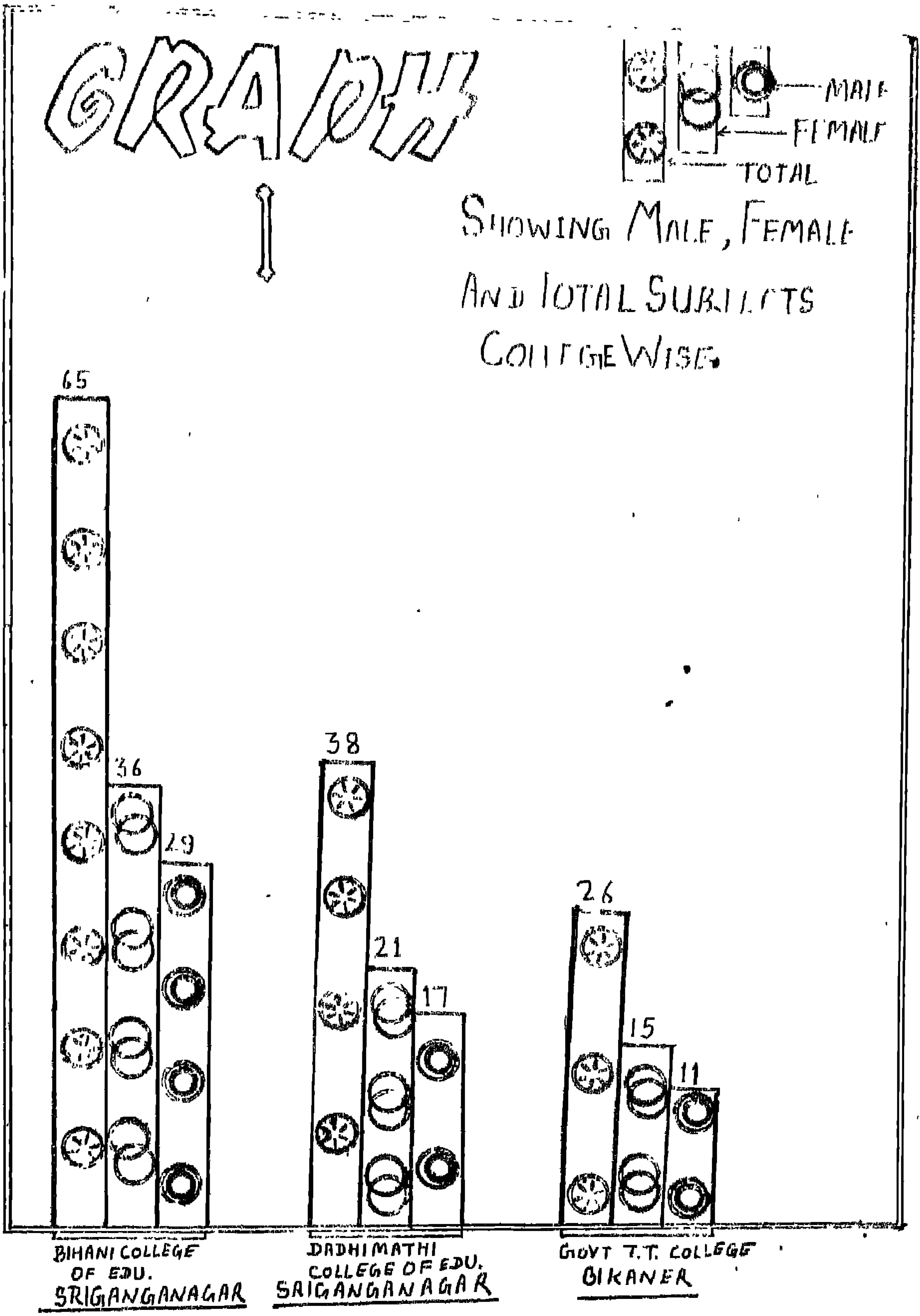
There are various factors affecting the sample. So the following considerations were kept in mind while selecting the subjects in the sample to make the sample fairly representative of the population.

1. That the sample is varying from 20 to 25 years of age.

2. That the subjects are from different socio-economic status.

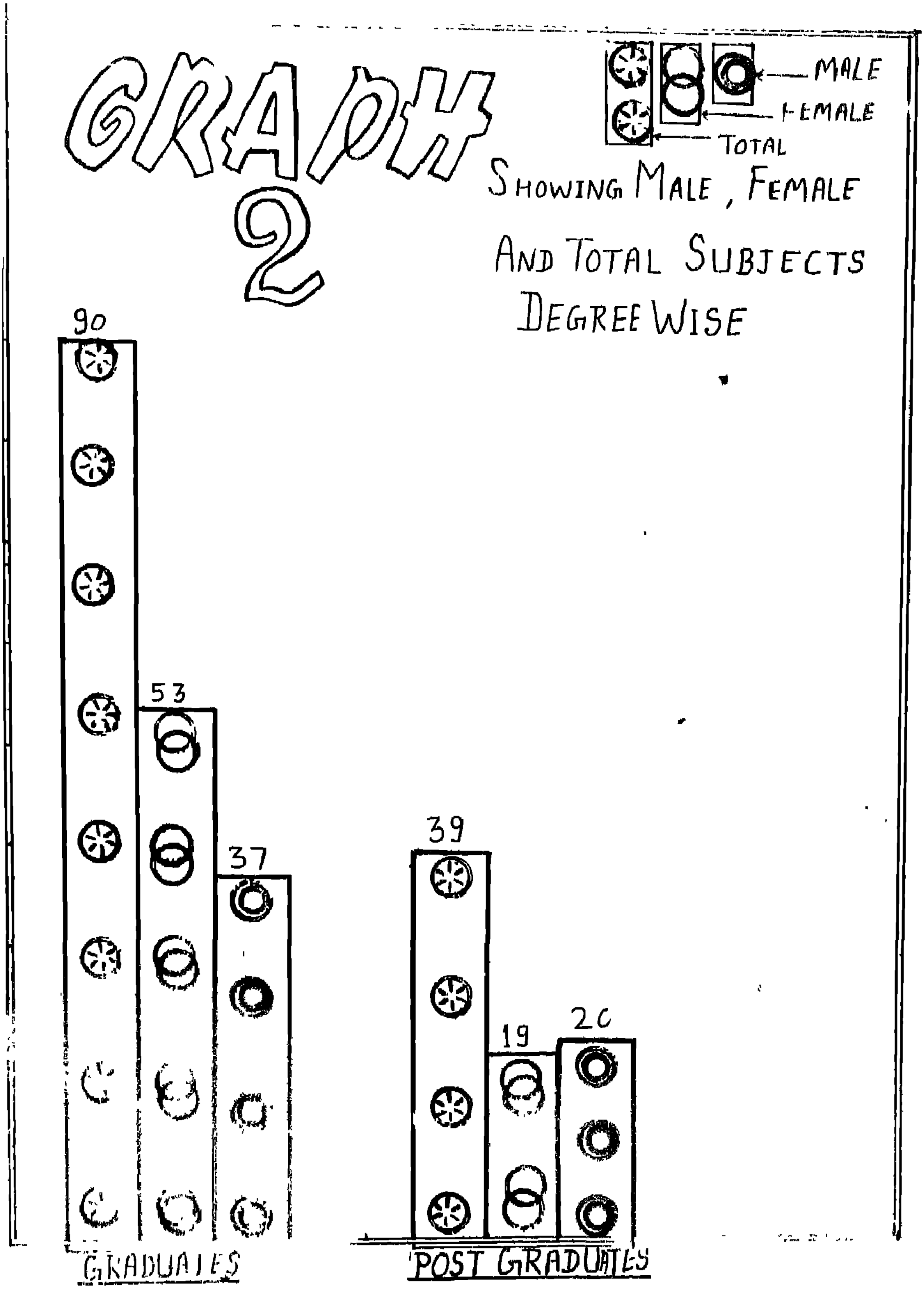
3. That the sample consists of both male and female student teachers.

4. That they belong to rural as well as urban areas.



GRAPH I

Showing Male, Female And Total Subjects College Wise


GRAPH 2
SHOWING MALE, FEMALE AND TOTAL SUBJECTS DEGREE WISE
MALE
FEMALE
TOTAL
90
53
37
39
19
20
GRADUATES
POST GRADUATES

THE PROCEDURE OF THE STUDY

After sampling, Raven's test of Piaget's logical operation (1973) was administered on the subject. The collected response sheets were scored out to categorize the student teachers under three different levels of cognitive maturity.

Meanwhile, the other tests were also administered and scored out. They were :

(i) Scientific Attitude Scale, constructed by Dr. Victor I. Billeh and George, A. Zakhariades (1975).

(ii) Verbal test of creative thinking, constructed by Baqer Mehdi (1973).

During internship programme the classroom verbal behaviours of student-teachers were encoded through Amidon and Hunter's (1966) verbal Interaction Analysis Technique (VICS) by the investigator. The observations of classroom verbal behaviour were displayed on matrix table and the data were subjected to computation of interaction categories, behaviour ratios and interaction variables. Master matrices were prepared for various groups and then groups were subjected to the comparison. Analysis of variance, significant difference between the mean, Chi-square, contingency coefficient and factor analysis were calculated for analysis purposes. After this the interpretations were made and suitable conclusions were drawn alongwith suggestions offered

for further research.

DESCRIPTION OF TOOLS

Raven's Test of Piaget's Logical Operation

The logical operations used for this were identified from an analysis of the growth of logical thinking (Inhelder, B. and Piaget, J., 1958) and the early growth of logic in the child (Inhelder, B. and Piaget, J., 1964).

The test comprises the following logical operations:

1. Classification operations
2. Seriation operations
3. Logical multiplication operations
4. Compensation operations
5. Proportional thinking operations
6. Probability operations
7. Correlational thinking operations

All these operations were described in detail by Raven (1973).

1. The Classification operation

(A) Complete sorting - A class may be formed by the union of all objects that exhibit common properties.

(B) Multiple Class Members - An object of a class may also be a member of another class.

(C) Horizontal re-classification - Objects may belong to two classes which are equally inclusive.

(D) Some and all - The quantifying object 'all' and 'some' may be used to compare the contents of a class and its sub-classes.

(E) Addition of classes - The total member of objects on sub-classes must run to the number of objects in the superordinate class.

(F) Division of Classes - Dividing a superordinate class yields sub-classes whose elements retain membership in the original class.

(G) Vertical reclassification - Objects may simultaneous membership in classes are progressively more or less inclusive.

(H) Quantitative Inclusion - The extension of classes are greater than any of their subclasses.

2. Seriation Operation

(A) Simple Seriation - Objects may be ordered according to change in a single variable.

(B) Complex seriation - Objects may be ordered according to change in two or more variables.

3. Logical Multiplication Operation

(A) Bi-univocal multiplication of classes - Units are classified according to two categories at the same time.

(B) Bi-univocal multiplication of relations - Units are grouped according to two relations of function at the same time.

(C) Co-univocal multiplication of relations - Units are grouped according to two series of relations at the same time.

4. Compensation Operation

(A) Negation - A system may be returned to equilibrium by returning the manipulated variable back to its original position and magnitude.

(B) Reciprocity I - A system may be returned to equilibrium by manipulating the direction and magnitude of the same variable but in different sub-system.

(C) Reciprocity II - A system may be returned to equilibrium by manipulating the direction and magnitude of a different variables in the sub-system.

(D) Reciprocity III - A system may be returned to equilibrium by manipulating the direction and magnitude of different variables.

5. Proportional thinking operation

The relative magnitude of a ratio may increase or decrease or stay the same with respect to the magnitude of another ratio if the magnitudes of the variable are changed.

6. Probability Operation

The object that has the greatest frequency is the one most likely to be chosen from a group.

7. Correlational Thinking

(A) Positive correlation - The formation of positive correlation occurs when the frequency of $(pq + \bar{p}q)$ is greater than the frequency of $(p\bar{q} + \bar{p}q)$.

(B) Negative correlation - The formation occurs when the frequency of $(p\bar{q} + \bar{p}\bar{q})$ is less than the frequency of $(p\bar{q} + \bar{p}q)$.

(C) No correlation - It occurs when the frequency of $(p\bar{q} + \bar{p}\bar{q})$ equals the frequency of $(p\bar{q} + \bar{p}q)$. A minimum of two items was used to assess each rule.

The operations mentioned above belong to the concrete and formal stages described by Piaget. The concrete stage contains operations which are carried out on the objects themselves. These operations result from the co-ordination of the actions of combining, dissociating, ordering and setting up of correspondence which then require the form of reversible (compensating) systems. The operations belong to the logic of classes and relations.

CONCRETE OPERATIONS

Stage III A -

It contains classification and seriation operations.

- The classification operational system is the inclusion of groups under each other.
- The seriation operational system links a symmetrical transitive relations into a system.

Both of these operative systems involve the arrangement of sub-systems within a system. They do not involve coordination between subsystems.

Stage III B -

It contains logical multiplication and compensation operations.

- The logical multiplication is the construction of correspondence between at least two sets of variables.

- The compensation is the balancing of two or more changeable variables.

Both of these operations involve the coordination of variables within and between sub-systems.

FORMAL OPERATIONS

Stage IV -

It contains operations which can be combined into a structured whole. The novel feature of their stage is the ability to reason by hypothesis. Hypothetico-deductive reasoning is characterized by the possibility of using any sort of data as purely hypothetical and reasoning correctly from them. Subjects between 12 to 15 years of age begin to formulate all of these possible hypotheses concerning the operative factors of a situation and then produce possible outcomes.

Stage IV A -

It contains proportional and probability thinking.

- Proportional thinking involves the construction of ratio.

- Probability operational thinking constitutes the construction of a ratio of the frequency occurrence of events.

Stage IV B -

It contains correlational thinking.

- Correlative thinking is the construction of a rule describing the relationship between two sets of events that have probability attached to their occurrence.

Reliability of the test -

Raven (1973) reported reliability co-efficient for the test as 0.79 by Hoyts method, while it was found 0.73 by the investigator by using test-retest method.

Validity of the Test -

Raven (1973) reports 4 different types of validity evidence, viz :

(i) Content validity
(ii) Criterion group validity
(iii) Inter sub-test correlation
(iv) Construct validity

Scoring procedure

Keeping in view the tradition of Piagetian type tasks scoring, the following system was used to score the test. (Tisher, 1962; Sheehan, 1970; Raven, 1973; Nordland et al, 1974; Lawson et al, 1975 a,b,c; Raven and Guerin, 1975; Lawson et al, 1976).

Stage III A = 1 mark (Early concrete operational)
Stage III B = 2 marks (Fully concrete operational)
Stage IV A = 3 marks (Early formal operational)
Stage IV B = 4 marks (fully formal operational)

Scoring procedure for each stage was given as :

Concrete operational Items

Classification 2 Items x 1 Mark = 2 Marks
Seriation 2 Items x 1 Mark = 2 Marks
Stage III A Total = 4 Marks

Logical multiplication 2 Items x 2 Marks = 4 Marks
Compensation 2 Items x 2 Marks = 4 Marks
Stage III B Total = 8 Marks

Formal Operational Items

Proportional thinking 2 Items x 3 Marks = 6 Marks
Probability thinking 2 Items x 3 Marks = 6 marks
Stage IV A Total = 12 Marks

Combinational thinking 2 Items x 4 Marks = 8 Marks
Stage IV B Total = 8 Marks
Total test marks = 32 Marks

The following scheme was used to categorise student teachers into concrete, transitional and formal thinking stages :

Range of marks	Category
0 - 12	Concrete operational
13 - 24	Transitional operational
25 - 32	Formal operational

Administration

The test was administered to each of the group (Biology and Mathematics) of the selected colleges. The

subjects were required to complete it within a period of 45 minutes. Average time taken by subjects to complete it ranged from 38 to 45 minutes. The test and scoring key is enclosed in Appendix 'A' and 'B'.

The Verbal Test of Creative Thinking

The verbal test of creative thinking was developed by Baqer Mehdi in 1973. In the preparation of the test four traits were considered, viz. fluency, flexibility, originality and elaboration. It is intended to deal with verbal content in a creative manner. Four types of activities are used for this purpose, viz. consequences, unusual uses, new relationships and product improvement.

The total time required for administering the test as suggested by manual is fifty-three minutes. The correlations between total activity scores with the grand total are from 0.761 to 0.862 for the urban sample and from 0.541 to 0.741 for the rural sample. Such high correlations indicate that while among themselves, they are not entirely measuring the same thing, each one is contributing significantly to the total creativity score. The reliabilities for factor scores range from 0.896 to 0.945 and that for total creativity score is 0.959. Inter scorer reliabilities for factor scores in one study were found to range from 0.65 to 0.98. Validities with teacher rating ranges from 0.29 to 0.40 for fluency, from 0.31 to

0.34 for flexibility and from 0.26 to 0.39 for originality. The correlation with verbal rating is 0.222 for total creativity score. The high validities showed enough to place influence in the use of the test. The manual also gives the scoring guide in a comprehensive manner. The test is enclosed in Appendix 'C'.

Scientific Attitude Scale (SAS)

The investigator has selected scientific attitude scale developed by victor Y. Billeh and George A. Zakhariades (1975) to measure scientific attitude among student teachers. The scale is based upon Thurstone chave design. The following six components of scientific attitudes were considered by author in the construction of the test.

1. Rationality
2. Curiosity
3. Open-mindedness
4. Aversion to superstitions
5. Objectivity
6. Suspended judgement.

The scale consists of 36 items out of which 18 are positive while 18 are negative. All these items were selected on the basis of 'S' (scale value) and 'Q' (Measure of variation) values. Before its use the scale was adopted in Indian conditions. A substantial change has been made in the original instrument. It is translated into Hindi and converted into five-point scale.

An initial try-out was also made on a small sample of prospective science teachers to determine the reliability of the instrument. The Pearsons correlated coefficient was calculated for scores on half 'A' and half 'B' (Split-half method). The Spearman Brown formula was applied to determine the reliability. It was found to be 0.71 instead of 0.55 to 0.74 observed by the author himself. The test is enclosed in appendix 'D'.

AMIDON AND HUNTER VERBAL INTERACTION CATEGORY SYSTEM

In order to explore the verbal behaviour of selected student teachers, Verbal Interaction Category System (VICS) developed by Amidon and Hunter (1966) was employed. As a matter of fact, this is an improvement over Flander's Interaction Analysis category system. So it attempts to categorize all the verbal behaviours to be found in the classroom. Modified categories are given in chapter I and also in Appendix 'E'. The categories are detailed below :

TEACHER - TALK

Indirect Teacher Behaviour

Category 1 : Acceptance of feeling

The teacher accepts feelings when he understands how children feel, that they have the right to have there feelings and that he will not punish the children for their feelings. These kinds of statements are often communicated to the children in terms of both the acceptance and the clarification of the feelings. This category includes the statements that recall past feeling, refer to enjoyable or

uncomfortable feelings that are present, or predict happy or sad events that are likely to occur in future. Acceptence of emotions in the classroom is quite rare, probably because teachers find it difficult to accept negative emotional behaviour.

Category 2 : Praise

This category includes jokes that release tension, but not those that threaten students or are made at the expense of individual student. Often praise is a single word, 'good', 'fine', or 'right', sometimes the teacher simply says. "I like what you are doing". These activities may be performed in the classroom, outside the classroom among students of other classes, or out side the classroom in private way. All these are performed in the school corresponding to the Praises (2a) Praises using public Criteria (2b) or Praises using private criteria (2c).

Category 3 : Accept ideas

This category is quite similar to category 1. However, it includes only acceptance of a student's ideas but non-acceptance of expressed emotions. When a student makes a suggestion, the teacher may paraphrase the students's statement, re-state the idea more simply or summarise what the student has said. The teacher may also say, "Well, that's an interesting point of view, I see what you mean". Statements belonging to category 3 can be identified by

asking the question, "Is the idea that the teacher is now stating is the student's or is it the teacher's"? If it is the student's idea, then this category is used, if it is the teacher's, another category must be employed. The idea may be :

1. Descriptive type :

When an idea is in the form of description, which a teacher repeats the idea based on some memorized concepts, the category '3a' will be used. In this low level of thinking process is involved.

2. Inference type :

Here the deductive process begins with one or more generalization which are assumed to be valid, and uses these to make inferences about specific situation the reasoning from general to the specific. Here high thinking process is involved. When this type of situation occurs, we code '3b'.

3. Generalization type :

As facts accumulate they may show patterns of relationship. A statement of one of these patterns is called generalization. Generalizations are much easier to deal with than marres of raw data, therefore, play an important role in organizing science into a comprehensible whole. In short generalisation means the summary of the critical and careful evaluation of the preceding step - into a general conclusion or statement of a principle, as the case may be. When this type of response is noted, then we code '3c'.

Category 4 : Asking Question

This category includes only such questions to which the teacher expects an answer from the pupils. If a teacher poses or asks a particular question and then follows it immediately with a statement of opinion, or if he begins lecturing, obviously the question was not meant to be answered. A theoretical question is not categorised as a question.

Amidon and Hunter (1966) VICS contains different type of questions. He calls those questions narrow whose specific nature of the response can be predicted. Drill questions and requiring one word or 'yes' or 'no' answer fall into this category. On the other hand, broad questions are relatively open ended and call for unpredic~~t~~table responses. In the words of Amidon and Hunter broad questions are those questions that are thought-proviking, that require reasoning or extended expression of opinion or feeling. A broad question is apt to elicit longer responses than the narrow question. Type of questions are given below :

Cognitive memory questions :

These questions are 'recall type' and require no additional thinking, anything that can be revived from the memory bank, we code '4a'.

Convergent questions :

These affect convergent thinking in which a number

of facts or ideas are organized and grouped together to reach a single conclusion.

Example :

1. 2 + 2 = ?
2. Given that barometric pressure, wind velocity, the amount and shape of clouds, what will be the weather tomorrow?

Hence, these questions require some analysis of data. It is a question whose single right answer may be obtained by the application of a rule or procedure. Here we code '4b'.

Divergent questions :

By divergent thinking (Guilford, 1959) means the ability of the child to start from one idea and to develop a number of adaptations or associations to that idea. So divergent questions affect divergent thinking.

Example :

1. How many ways can you think to get 4?
2. List all of the things that you can think of that might influence our weather tomorrow.

Hence, these questions call for imagination and move in new direction. The student is permitted among alternative or to create ideas of his own. In this situation we code '4c'.

Evaluative questions

These questions ask for judgement. Development of relevant criteria such as usefulness desirability, social consequences is implied and then the application of the criteria to be issued, we code '4d'.

It can be represented as :

Narrow		Broad	
Cognitive memory	Convergent	Divergent	Evaluative
Recall	Explain	Predict	Judge
Identify observe	State relationship	Hypothesize	value
Yes or No	Compare	Infer	Defend
Define	Contrast	Reconstruct	Justified
Name	x	x	Choice

Direct Teacher Talk

Category 5 : Lecturing

Lecture is the form of verbal interaction that used to give information, facts, opinions, or ideas to children. The presentation of material may be used to introduce, review or focus the attention of the class on an important topic. Usually, information in the form of a lecture is given in fairly extended time periods, but it may be interspersed with children's comments, questions and encouraging the praise. Whenever, the teacher is explaining, discussing, giving opinion or giving facts or information, category 5 is used. Rhetorical questions are also included in this category.

Category 6 : Give direction

The decision about whether or not to classify statements as a direction or command must be based on the degree of freedom that the student has in response to teacher direction. When the teacher says, "will all of you keep silence and do the class work"? he is obviously giving a direction. If the teacher asks a boy to go the board and write student's names, "the teacher is giving a direction or command". When he says, to a particular pupil, "I want you to tell me what you have done with your reader", he is still giving a direction. Some times teacher helps student in responding. It is also included in this category.

Category 7 : Criticises

A statement of criticism is one that is designed to change student behaviour from non-acceptable to acceptable. The teacher is saying, in effect, "I do not like what you are doing, Do something else". Another group of statements included in this category are those that might be called statements of defence or self-justification. Other kinds of statements that fall in this category are those of extreme self-reference or those in which the teacher is constantly asking the children to do some thing as a special favour to the teacher. If it happens in classroom we code '7a' criticises. When it occurs out side the classroom among other student it will be called as criticism using public

criteria and we note a '7b'. While when student is being criticised by teacher in private way we code '7c'.

Pupil-Talk

Student Behaviour

Category 8 : Pupil response

This category is used when the teacher has initiated the contact or has solicited student's statements, when the student answers a question asked by the teacher, or when he responds verbally to a direction that teacher has given. Anything that the student says, that is clearly in response to initiation by the teacher, belongs to category 8. On the basis of type of response, description, inference or generalisation we code '8a', '8b' and '8c' respectively. These three terms are described in category 3.

Category 9 : Pupil initiation

In general, if the student raises his hand to make a statement or to ask a question when he has not been prompted to do so by the teacher, the appropriate category is '9'. When in response to a teacher's question the student given an answer different from that which is expected for the particular question, that statement is categorised as in category '9'. The type of statement may be descriptive, inference or generalisation form so we code '9a', '9b' and '9c' respectively.

Other Events

Category 10 : Silence or Confusion

When no activity is performed in the classroom we code '10a' - the silence. This category includes anything else not included in other categories. In science when teacher demonstrates, displays charts, draws diagram and writes concepts on Black Board no verbal activity takes place and we code '10a'. When it is difficult to determine who is talking, a periods of confusion in communication, we code '10b'.

The classroom interaction analysis may be defined as "any system for coding spontaneous verbal communication, arranging the data into a useful display, and than analysing the result in order to study the patterns of teaching and learning.

The interaction analysis usually includes :

(a) Set of categories each defined clearly.

(b) A procedure for observation and a set of ground rules which govern the coding process.

(c) Steps for tabulating the data in order to arrange a display which aids in describing the original events, and

(d) Suggestions which can be followed in some more common applications.

Amidon and Hunter's (1966) VIVS can objectively be used to measure the teaching effectiveness of teachers. So many researches (Filson, 1957; Lashier, 1965; Johns, 1966; Morrison, 1966; Soar, 1966; Frust, 1967; Weber, 1968; Flander, 1970; Fanney, 1969; Lulla, 1973; Pareek & Rao, 1971; Pavanasam, 1977 and other) state that significant positive relationship exists between indirect teacher behaviour and pupil achievement. So it is assumed by the investigator that prospective teachers whose behaviour is indirect will be considered more effective than the direct teaching behaviour. Similarly teacher flexibility can also be calculated.

Direct Influence

It consists of stating the teacher's own opinions or ideas, directing the pupil's action, criticising his behaviour, or justifying the teacher authority or use of that authority. This concept refers to actions taken by the teacher which restrict student participation, expressing one's own views through lecture, giving directions, and criticising with the expectation of compliance tend to restrain pupil participation.

Indirect Influence

It consists of soliciting the opinions or ideas, applying or enlarging the opinions or ideas, praising or encouraging the participation, or clarifying and accepting

feelings of pupils. In other words it is defined as action taken by the teacher who encourages and supports students participation. Accepting, clarifying, praising and developing the ideas and feelings expressed by the pupils support student participation.

Teacher Flexibility

It is a measure of the change a teacher makes in his verbal influence from one activity period to another. It is measured by noting the ratio of indirect influence to direct influence in activity period and comparing it with the corresponding ratio in other activity period.

Encoding and decoding are the two processes of interaction analysis. The encoding process is observation matrix by coding the numbers of categories. The decoding is a process of interpreting observation matrix. These processes have been discussed below :

Encoding Process of the Classroom Verbal Interaction

Amidon and Hunter's system of interaction analysis is employed in order to collect the data regarding classroom verbal behaviour of student teachers. The encoding procedure begins by memorising the categories. The observer sits in a classroom in the best position to hear and see the participants. At the end of each three-second period, he decides which category best represents the communication

events just completed. He writes down this category number on data sheet while simultaneously, assessing communication in the next period and continues at a rate of 20 observations per minute. Notes are merely a series of numbers written in a column, top to bottom, so that the original sequence of events is preserved.

Occasionally, marginal notes are used to explain the class formation or any unusual circumstances. When there is a major change in class formation, the communication pattern, or the subject under discussion, a double time is drawn and the time is indicated. As soon as the total observation is completed, the observer retires to a nearby room and completes a general description of each separate activity period, separated by the double lines, including the nature of activities, the class formation and the position of the teacher. The observer also notes any additional facts that seem pertinent to an adequate interpretation. The proforma used for encoding verbal interaction has been provided in Appendix F.

Ground Rules for Encoding Procedure

Because of the complexity of the problems involved in categorisation, several ground rules have been established. These rules of observation help in developing consistency in trying to categorise teacher behaviour.

Rule 1. When not certain in which two or more categories a statement belongs, choose the category that is

numerically farthest from category 5.

Rule 2. If the primary tone of the teacher's behaviour has been consistently direct or consistently indirect, do not shift into the opposite classification unless a clear indication of shift is given by the teacher.

Rule 3. The observer must not be concerned with his own biases or with the teacher's intent.

Rule 4. If more than one category occurs during the three-second interval, then all categories used in the interval are recorded, therefore, record each change in category. If change does not occur within three second, repeat that category number.

Rule 5 If a silence is longer than three second it is recorded as '10a'.

Rule 6 When the teacher calls a child by his name, the observer ordinarily records '4a'.

Rule 7 When the teacher repeats a student's answer and if the answer is correct one, this is recorded as '2a'.

Rule 8 When the teacher repeats a student's idea and communicates that the idea will be considered or accepted as something to be discussed, '3a' is used.

Rule 9 Reactions such as 'All Right', 'Okay' and 'Yes' etc. are recorded as '2a'.

Rule 10 Rhetorical questions are recorded as 5.

The importance of preserving the sequence when categorising teacher statements lies in analysis. An analysis

can be made of the frequency of events in each category. A profile of the distribution can be drawn or a simple display can be created which shows how each event is a part of the chain. Inference about the chain of events can be made keeping in mind the limitations of over-all process.

Constructing an Interaction Matrix

After coding, the data is tabulated on 24 x 24 matrix table. To tabulate these observations in a 24 x 24 matrix, the first step is to make sure that the entire series begins and ends with the same number. The convention we use is to add a '10a' to the beginning and end of the series unless then '10a' is already present, for example, the series may be like '10a', '6', '10a', '7a', '5', '1', '4a', '8c', '4a' and '10a'.

The numbers are tabulated in a matrix, one pair at a time. The column is indicated by the second number, the row is indicated by the first number, for example.

Pair II   Pair IV   Pair VI   Pair VIII
10a 6   10a 7a   5 1   4a 8c   4a 10a
Pair I   Pair III   Pair V   Pair VII   Pair Ix

The first pair is 10a-6, the tally is placed in row 10a, column 6 cell. The second pair is 6-10a, the third pair is 10a-7a, the fourth pair is 7a-5, and so on. Each pair overlaps with the next and the total number of observations, 'N' always will be tabulated by N-1 tallies

in the matrix. Ordinarily, a separate matrix is made for each specific lesson or major activity. Matrices are more meaningful, when they represent a single type of activity or work. Cells in the observation matrix have been shown in appendix F. The whole process is called decoding. Precautions, used in Amidon and Hunter Interaction category System :

There are five precautions recommended by pioneer workers in the field with regard to use of interaction analysis. These were also followed by the researcher in the present study.

1. No interaction analysis data should be collected unless the person observed is familiar with the entire process and knows its limitations.

2. The question, to be answered, by inspecting the matrix should be formulated, before the observation takes place.

3. Value judgement, about good and bad teaching behaviour should be avoided and the emphasis should be given to study the cause-effect relationship with respect to problem under investigation.

4. Certain amount of defensive behaviour is likely to represent at the critical consultation.

5. A consultation, based on two observations or at least two matrices, helps to eliminate value judgement or at least control them. Comparisons between the matrices are more likely to lead to the principles.

FIVE STEPS FOR MATRIX INTERPRETATION

There are five steps of matrix interpretation, which help to pin down some general features of the classroom, interaction and which together form a situational setting. These steps are :

1. Check the matrix total in order to estimate the elapsed coding time.

2. Check the present teacher talk, pupil talk and silence or confusion and use their information in communication with.

3. Check the balance of teacher response and initiation in contrast with pupil initiation.

4. Check the initial reaction of the teacher to the termination of pupil talk.

5. Check the proportions of tallies to be found in the 'content cross' and 'steady state class' in order to estimate the rapidity of exchange, tendency towards sustained talk and content emphasis.

STATISTICAL TECHNIQUE

Statistical techniques were used in the analysis of present investigation. These techniques were applied for estimating intra-observer reliability and ascertaining the relationship between teachers' intellectual levels and components of teacher behaviour.

Scott's Formula for Estimating Intra and Inter Observer Reliability

A method of estimating reliability should be as simple and quick to calculate as possible. Bales (1950) proposes an adaptation of chi-square which was found to be less appropriate for our purposes than was Scott's (1955) coefficient. Scott's method is uneffected by low frequencies, can be adopted to % figures, can be estimated more rapidly in the field and is more sensitive at higher level of reliability.

Scott calls his coefficient "Pi" and it is determined by the two formulas mentioned below :

$$(1) \quad \pi = \frac{P_o - P_e}{1 - P_e} \quad \ldots . (1)$$

where 'P_o' is the proportion of agreement and 'P_e' is the proportion of agreement expected by chance, which is found by squaring the proportion of tallies in each category and summing these over all categories.

$$(2) \quad P_e = \sum_{1}^{k} = 1 \, P^{2}{}_{i} \quad \ldots . (2)$$

where, 'k' categories and 'Pi' is the preposition of tallies, falling into each category. π , in the formula can be expressed in words, as the amount that two observers or one observer, in two different sittings, exceeded chance agreement, divided by the amount, that perfect agreement exceeds chance.

i.e. $$\pi = \frac{\text{Total agreement between observer} - \text{Chance agreement}}{\text{Greatest possible agreement} - \text{Chance agreement}}$$

Scott's co-efficient provides a simple and quick method of estimating inter and intra observer reliability.

Statistical Treatments

For the analysis of the data, the following statistical treatments were used :

Descriptive statistics

The descriptive statistics like Mean and Standard deviation were employed to know the nature of distribution.

Contingency Coefficient 'C'

The coefficient of contingency, 'C' provides a measure of correlation when each of the two variables under study has been classified into two or more categories. In the present investigation computation of 'C' in a 3 x 3 fold classification was used. It is calculated by using the following formula :

$$C = \sqrt{\frac{S - N}{S}}$$

where 'C' is coefficient of contingency, 'S' is the sum of the quotients and 'N' is the size of the sample.

Chi-Square χ^2

The χ^2 was also computed from the contengency table by using the given formula :

$$\chi^2 = \sum \left[\frac{(f_o - f_e)^2}{f_e} \right]$$

Where χ^2 is symbol of chi-square, 'f_o' is frequency of occurrence of observed facts, 'f_e' is expected frequencies. A relationship exists between χ^2 and contingency coefficient 'C' which is tested by the formula :

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

Analysis of Variance - (F)

The one-way analysis of variance was used to study the significant difference among three groups in relation to the eleven behaviour ratio.

The t-Test

The 't'-test was employed to find out the significance of difference between two means, where 'F' is significant.

Factor Analysis

(a) Principal - axis method of factor analysis was used to study the factorial structure of Science teaching pupils.

(b) Varimax rotation on the lines of Kaiser (1959) was done to interpret the factors. Calculations were done at Council for Social Development, New Delhi.

CHAPTER IV

ORGANISATION, ANALYSIS AND INTERPRETATION OF DATA

INTRODUCTION

In order to study the relationship between Piagetian Cognitive maturity, Scientific attitude and verbal creativity, tests were administered to the pupil teachers and scored out. After scoring they were categorized (See Appendix A). The creativity score is being converted into 'T' scores as suggested in the manual. The mean scores and standard deviation are being summarised in the following tables :

Table 3

Number of students, their mean scores and standard deviation on Raven's Test of Piagetian logical Operation

	Male	Female	Total
Concrete (31)	9.714 (1.773)	10.176 (1.714)	9.968 (1.741)
Transitional (65)	16.857 (1.193)	19.033 (1.622)	18.936 (2.133)
Formal (33)	26.615 (1.193)	27.000 (1.622)	26.848 (2.133)
Total	18.419 (5.991)	19.164 (6.648)	18.806 (6.327)

Table 3 shows that 31 teachers were at concrete level, 65 were at transitional level while 33 were at formal level. Their mean scores were 9.968, 18.936 and 26.848

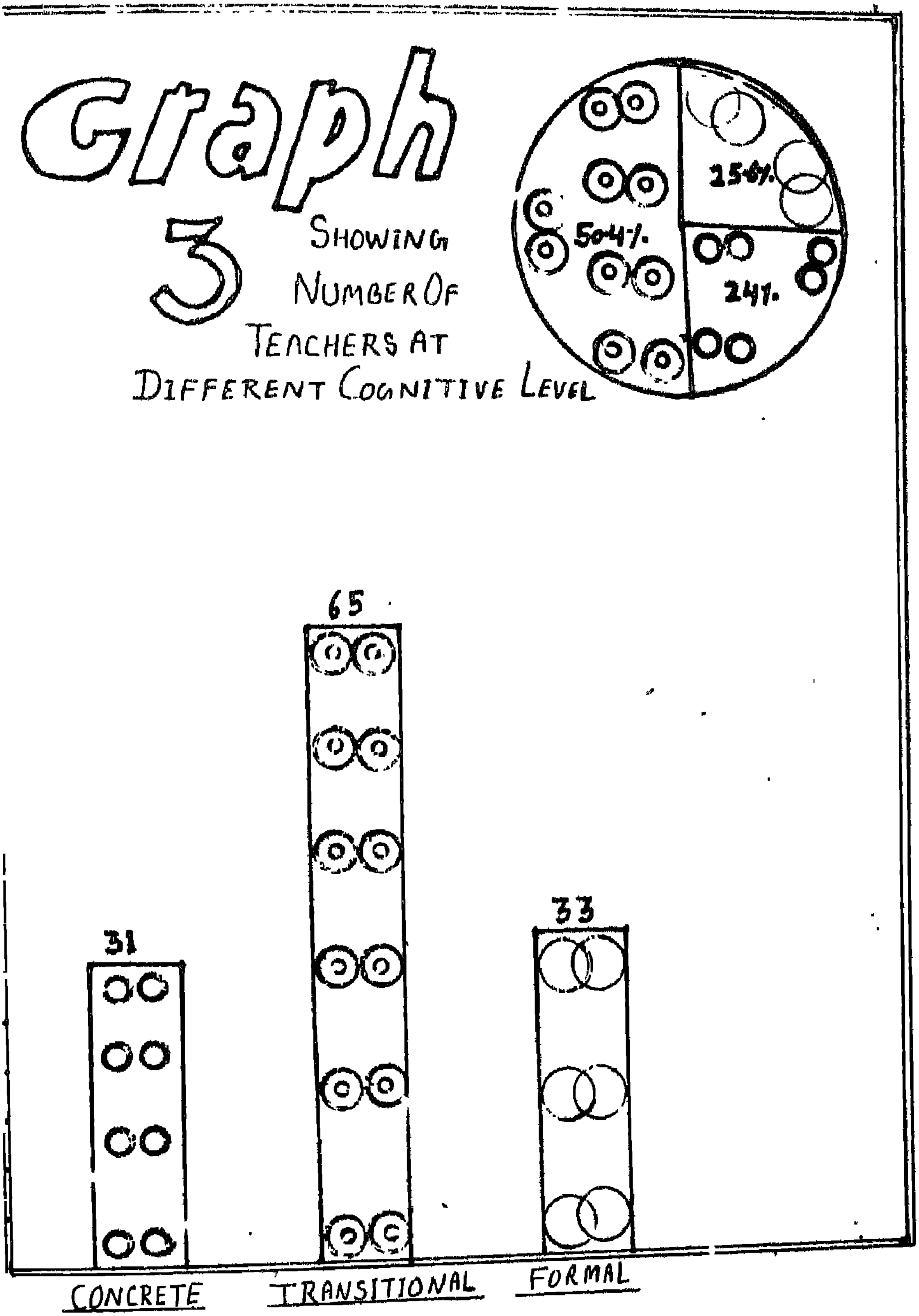
respectively. It means that formal teachers have scored higher on Piagetian test than concrete and transitional group. The table also shows that mean scores of male and female is more or less similar. Hence, in the study sex difference is not considered. This table is also represented in graphs 3 and 4, (placed at page No.108, 109).

Table 4

Mean scores and S.D. of Concrete, transitional and formal group on Scientific attitude test

	Male	Female	Total
Concrete	126.571 (9.387)	131.588 (10.363)	129.323 (10.094)
Transitional	130.400 (11.322)	132.433 (8.429)	131.338 (9.999)
Formal	126.692 (9.114)	127.900 (8.510)	127.242 (8.632)
Total	128.758 (10.494)	130.866 (8.983)	129.853 (9.758)

Table 4 shows that on scientific attitude test the difference between mean scores of concrete, transitional and formal group was not very much. Similarly male pupil teachers and female pupil teachers performed more or less equal on this test.



Graph 3

Showing Number Of Teachers At Different Cognitive Level

GRAPH 4

SHOWING MEAN SCORES OF CONCRETE, TRANSITIONAL AND FORMAL TEACHERS ON LOGICAL OPERATION TEST.

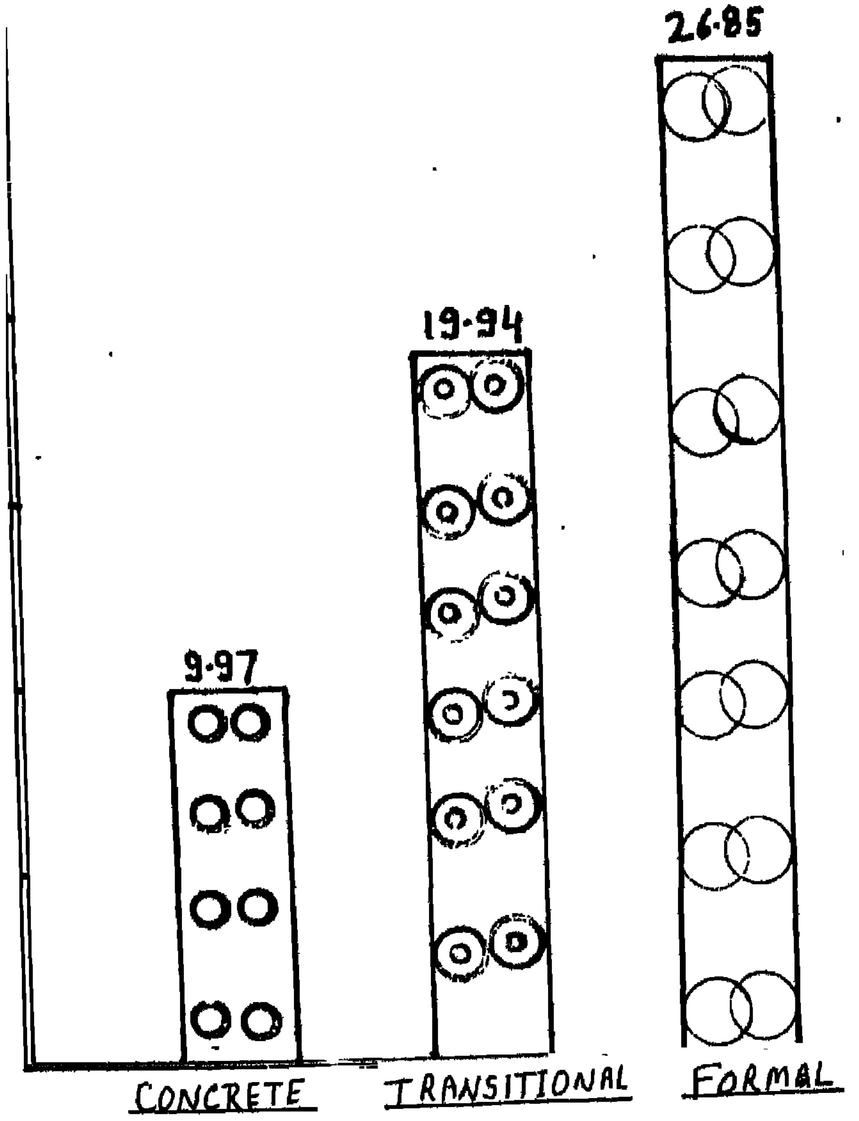


Table 5

Mean Scores and S.D. of concrete, transitional and formal group on verbal test of creativity

	Male	Female	Total
Concrete	146.357 (28.139)	157.209 (24.061)	152.613 (23.603)
Transitional	151.571 (24.633)	148.200 (25.547)	150.015 (24.919)
Formal	145.000 (26.470)	153.500 (25.975)	150.152 (26.099)
Total	149.016 (25.565)	152.209 (24.061)	150.674 (24.749)

Table 5 shows that mean scores on creativity test were more or less similar at three different levels of cognitive maturity. Similarly, slight difference was seen between the mean scores of male pupil teachers and female pupil teachers on creativity. While male has 149.016 mean score, female has 152.209.

ORGANISATION OF DATA FOR BEHAVIOUR RATIOS

In the investigations of interaction analysis one of the rigorous analyses is the interpretation of teacher pupil interaction in terms of behaviour ratios. This method requires a simple ratio based on observations of matrix. In the present investigation, elevel important behaviour ratios were considered, the collected data for each behaviour ratios were organised into frequency distribution table

with regard to concrete, transitional and formal operational groups. The details are as follows :

1. **Teacher Talk (TT)**

It may be defined as action taken by the teacher that reflects the tendency of teacher talk. The teacher-talk (TT) is calculated by adding the frequencies of 1 to 7 categories multiplying by 100 and dividing by the total tallies (N) of the matrix. It may be written as :

$$TT = \frac{1 + (2a + 2b + 2c) + (3a + 3b + 3c) + (4a + 4b + 4c + 4d) + 5 + 6\,(7a + 7b + 7c)}{N} \times 100$$

The teacher-talk ratio was seen to range from 32.00 to 79.00 in concrete group, 21.00 to 74.00 in transition group and 36.00 to 81.00 in formal group.

2. **Indirect Teacher-Talk (ITT)**

The indirect teacher's influence may be defined as actions taken by the teacher, which encourage and support student's participation. Accepting, clarifying, praising and developing the ideas and feelings expressed by the pupils will support the student's activities. Indirect Teacher talk can be operationally defined by noting down the percentage of teacher statements falling into categories 1, 2a, 2b, 2c, 3a, 3b, 3c and 4a, 4b, 4c. The indirect teacher-talk was computed by using the following formula :

$$ITT = \frac{1 + (2a+2b+2c) + (3a+3b+3c) + (4a+4b+4c+4d)}{N} \times 100$$

The Indirect Teacher-talk ratio in this study ranged from 8 to 37 in concrete operational group, 8 to 52 in transitional operational group and 11 to 50 in formal operational group.

Direct Teacher - Talk (DTT)

The direct influence refers to actions taken by the teacher which restrict student participation. Expressing one's own views through lectures, giving directions and criticism with the expectation of compliance to restrict pupil's participation. This behaviour may be operationally defined by counting the percentage of teacher statements falling into 5, 6 and 7a, 7b, 7c, categories. The DTT has been computed by adding the tallies of the above-mentioned categories and multiplying by 100 and dividing by the total tallies in the matrix. It can be written as :

$$DTT = \frac{5 + 6 + (7a + 7b + 7c)}{N} \times 100$$

In the present study the ratio ranged from 4 to 57 in concrete operational group, 1 to 49 in transitional operational group and 4 to 55 in formal operational group.

Pupil-talk (PT)

It referred to categories 8a, 8b, 8c and 9a, 9b, 9c as indicative of pupil-talk. It may be defined as the percentage of student-talk falling into the above-mentioned categories. The PT was calculated by using the formula :

$$PT = \frac{(8a + 8b + 8c) + (9a + 9b + 9c)}{N} \times 100$$

It was noticed that the ratio ranged from 5 to 27 in concrete operational group, 6 to 38 in transitional operational group and 7 to 39 in formal operational group.

Silence or Confusion (S/C)

The period of confusion or silence in communication, which is not understood by the observer or when it is difficult to determine who is talking, is classified in this category. The silence or confusion can be defined operationally by noting down the percentage of category 10a and 10b. It was computed by the formula :

$$S/C = \frac{10a + 10b}{N} \times 100$$

It was obtained that silence or confusion ratio ranged from 5 to 61 in concrete operational group, 6 to 71 in transitional group and 1 to 51 in formal operational group.

Indirect to Direct Ratio (I/D)

This ratio may be operationally defined by noting down the proportion of indirect influence to direct influence of the teacher. In VICS (Amidon and Hunter) it referred to categories 1; 2a, 2b, 2c; 3a, 3b, 3c and 4a, 4b, 4c, 4d as indicative of "indirect teacher influence" and categories 5, 6, and 7a, 7b, 7c as "direct teacher influence". Hence, it can be computed by using the following formula :

$$\text{I/D Ratio} = \frac{1 + (2a+2b+2c) + (3a+3b+3c) + (4a+4b+4c+4d)}{5 + 6 + (7a + 7b + 7c)}$$

The data indicated that I/D Ratio ranged from 0 to 7 in concrete operational group, 0 to 35 in transitional operational group and 0 to 8 in formal operational group.

Small Indirect to Direct Ratio (i/d)

The ratio may be operationally defined by noting down the proportion of responses of categories 1; 2a, 2b, 2c and 3a, 3b, 3c and initiation portion of categories 6 and 7a, 7b, 7c. Hence, it can be computed by adding the tallies in 1; 2a, 2b, 2c, 3a, 3b, 3c categories and dividing by the total tallies of 6, 7a, 7b, 7c categories. It can be written as :

$$\text{i/d Ratio} = \frac{1 + (2a+2b+2c) + (3a+3b+3c)}{6 + (7a + 7b + 7c)}$$

The ratio ranged from 0 to 21 in concrete operational group, 0 to 27 in transitional operational group and 0 to 27 in formal operational group.

Pupil Initiation Ratio (PIR)

PIR is proposed to indicate what proportion of pupil-talk has been judged by observer to be an act of initiation. The PIR can be defined by noting down the percentage of category 9a, 9b, 9c. It can be calculated by multiplying the frequency in category 9a, 9b, 9c by 100 and dividing by the sum total of pupil talk represented by

the total of categories 8a, 8b, 8c and 9a, 9b, 9c. It can be represented as :

$$PIR = \frac{9a + 9b + 9c}{(8a+8b+8c)+(9a+9b+9c)} \times 100$$

The PIR ranged from 0 to 35 in concrete operational group, 0 to 55 in transitional operational group and 0 to 22 in formal operational group.

Teacher Response Ratio (TRR)

The TRR is defined as an index which corresponds to teacher's tendency to react to the idea and feelings of the pupils. This can be found by adding the frequencies of categories 1; 2a, 2b, 2c; 3a, 3b, 3c, multiplying by 100 and dividing by the sum of categories 1; 2a, 2b, 2c; 3a, 3b, 3c; 6 and 7a, 7b, 7c. It can be presented as :

$$TRR = \frac{1 + (2a+2b+2c) + (3a + 3b + 3c)}{1 + (2a+2b+2c) + (3a+3b+3c) + 6 + (7a+7b+7c)} \times 100$$

The obtained TRR ranged from 0 to 95 in concrete operational group, 13 to 100 in transitional operational group and 11 to 100 in formal operational group.

Teacher Question Ratio (TQR)

It is defined as an index representing the tendency of a teacher to use questions when guiding the more content oriented part of the class discussion. The TQR is the percentage of statements classified in categories 4a, 4b, 4c, 4d out of all the statements related to categories 4a, 4b, 4c, 4d and 5. It can be calculated by the formula :

$$TQR = \frac{4a + 4b + 4c + 4d}{(4a+4b+4c+4d) + 5} \times 100$$

It was observed that the obtained TQR ranged from 15 to 90 in concrete operational group, 21 to 100 in transitional operational group and 17 to 98 in formal operational group.

Content Cross Ratio (CCR)

The proportion of the classroom activities related to the teacher's questions and lecture represents an important feature of classroom interaction. The CCR is an indication that the main focus of class discussion was on the subject-matter, that the teacher took very active role in class discussion and that attention to motivation and discipline was a minimum. The CCR is obtained by calculating the percentage of all tallies that lie with the columns or rows of categories 4a, 4b, 4c, 4d and 5. It can be computed by adding the frequencies of the above-mentioned categories, multiplying them by 100 and dividing by total tallies in the matrix. It can be written as :

$$CCR = \frac{(4a + 4b + 4c + 4d) + 5}{N} \times 100$$

The obtained values of CCR ranged from 26 to 76 in concrete operational group, 15 to 72 in transitional operational group and 21 to 77 in formal operational group.

The obtained data for the above-mentioned eleven behaviour ratios for concrete, transitional and formal

TABLE 6A

MASTER MATRIX OF CONCRETE GROUP [24X24 MATRIX TABLE]

CAT.		1	2			3			4				5	6	7			8			9			10		T	G.T
			a	b	c	a	b	c	a	b	c	d			a	b	c	a	b	c	a	b	c	a	b		
1						1		2	4									6								13	13
2	a		3						59	1	1	13	15					5						15		112	113
	b																										
	c										1															1	
3	a		74			15			107	1	4	2	59	1				3			3			62		341	381
	b		2							1																3	
	c		20		1			3		1	3	5	3											1		37	
4	a	13	3			4			917		1		50	35	14			312	1	3	10	1		100	20	1934	2444
	b					1				18								9	8						1	37	
	c							1		2	91	4		2				36	1	25				5	2	169	
	d											149	3	3				29		68				2		254	
5						2			249		16	15	2723	2	14			2			23			181	1	3228	3228
6									41		6	2	8	37	1			18	2					8		123	123
7	a					1			50		4	2	23	1	53			2			1			23		160	160
	b																										
	c																										
8	a		10			306		5	267	5	21	6	129	26	58			762			6			108		1709	1940
	b					1	3		4	1		1	1	1					8						1	21	
	c					10		26	9		5	18	7	1	1					114				18	1	210	
9	a								30				12	1	5			2			39			14		103	106
	b								1													1		1		3	
	c																										
10	a								240	6	13	35	178	11	14			22			21	1		3264		3805	3861
	b								6	1	3	2	7	2				1	1					3	30	56	
TOTAL		13	112		1	341	3	37	1984	37	169	254	3228	123	160			1709	21	210	103	3		3805	56	12369	
G.TOTAL		13	113			381			2444				3228	123	160			1940			106			3861			12369

TABLE 6 B

10 × 10 MATRIX TABLE : CONCRETE GROUP

CAT.	1	2	3	4	5	6	7	8	9	10	TOTAL
1			3	4				6			13
2		3		75	15			5		15	113
3		97	18	124	72	1		3	3	63	381
4	13	3	6	1182	53	40	14	992	11	130	2444
5			2	280	2723	2	14	2	23	182	3228
6				49	8	37	1	20		8	123
7			1	56	23	1	53	2	1	23	160
8		10	351	337	137	28	59	884	6	128	1940
9				31	12	1	5	2	40	15	106
10				306	185	13	14	24	22	3297	3861
TOTAL	13	113	381	2444	3228	123	160	1940	106	3861	12369
%	0·11	0·91	3·08	19·76	26·1	0·99	1·29	15·68	0·86	31·22	

ITT 2951 (23·86%)

DTT 3511 (28·38%)

ST 2046 (16·54%)

S/C 3861 (31·22%)

TT 6462 (52·24%)

I/D Ratio (1·46), i/d Ratio (4·74), PIR (6·58), TRR (59·09), TQR (46·87), CCR (45·84)

operational group have been summarised in Appendix 'H'.

PREPARATION OF THE MASTER MATRICES

Classroom verbal behaviour of concrete, transitional and formal operational student teachers was observed through VICS (Amindon and hunter). Each subject was observed for about 20 minutes during a period of teaching. The obtained data were tabulated on observation matrix tables. Thus 129 matrices were prepared by way of plotting the data on 24 x 24 matrix tables. These matrices were subjected to computation of 11 important behaviour ratios for further statistical analysis.

These matrices were pooled to evolve composite matrices, called master matrices, for concrete, transitional and formal operational groups separately. The three master matrices have been presented in tables 6a, 7a and 8a. These matrices were further translated into 10 x 10 matrix tables showing 11 important behaviour ratios. These tables are represented as 6b, 7b and 8b respectively.

Table 6b indicates the master matrix of 31 concrete operational teachers. The total number of tallies is 12,369 for 31 observed ~~few~~ lessons pooled together. There was 52 percent teacher talk, 17 percent student talk and 31 percent silence or confusion. The percentage of Indirect Teacher Talk and Direct Teacher Talk were 23.86 and 28.38 percent respectively. Out of the total student-talk there was 16 per cent student talk response and only one percent

TABLE NO. 7 A

MASTER MATRIX OF TRANSITIONAL GROUP [24X24 MATRIX TABLE]

CAT-		1	2			3			4				5	6	7			8			9			10		T.	GT
			a	b	c	a	b	c	a	b	c	d			a	b	c	a	b	c	a	b	c	a	b		
D1		19	1			2			40		3	3			2			47	1		1			3		122	122
2	a		29			2			79	3	6	5	21	1	1			12			2			48		209	209
	b																										
	c																										
3	a	2	116			118			336	8	33	22	103	5	1			10			2			165		928	962
	b		1						3		2		1									1		1		9	
	c		1					9	1		2	1		1						5				4		25	
4	a	79	6			5			2493	3	8	2	73	160	20			1392	2	1	15			307	36	5102	6205
	b									44			1	2	3			26	5					3		84	
	c	6							2		370		6	12	3			178	23	37	1			27	12	677	
	d	5							1			194	3	8	1			31	1	35	3			10		342	
5								1	428	3	35	13	3328		2			3			41			312	1	4233	4233
6						2			142	1	13	9	16	198	6			33	3	2	2			21	4	502	502
7	a	1				2			122	4	8	5	29	7	82			34		3	8			41	4	350	351
	b															1										1	
	c																										
8	a	5	53			777		1	700	8	95	35	235	42	165			1762		2	31			272	1	4184	4438
	b		1			9	9		1	1	5	1	3	2				1	33					3		69	
	c		1			10		14	16		6	19	2	2	2			2		98				13		185	
9	a					1			31		2	4	31	1	38			15			125			36	1	285	300
	b																		1							1	
	c																						13	1		14	
10	a	5							684	9	79	29	311	57	21			27		1	52		1	7180	2	8458	8613
	b								23		10		10	4	3			5			2			4	94	155	
TOTAL		122	209			928	9	25	5102	84	677	342	4233	502	350	1		4184	69	185	285	1	14	8458	155	25935	
G.TOTAL		122	209			962			6205				4233	502	351			4438			300			8613			25935

TABLE 7. B

10x10 MATRIX TABLE: TRANSITIONAL GROUP

CAT-	1	2	3	4	5	6	7	8	9	10	TOTAL
1	19	1	2	46			2	48	1	3	122
2		29	2	93	21	1	1	12	2	48	209
3	2	118	127	408	104	6	1	22	3	171	962
4	90	6	5	3117	83	182	27	2281	19	395	6205
5			1	479	3388		2	3	41	319	4233
6			2	165	16	198	6	88	2	25	502
7	1		2	139	29	7	83	37	8	45	351
8	5	55	820	887	240	46	167	1898	31	289	4438
9			1	37	31	1	38	16	138	38	300
10	5			834	321	61	24	33	55	7280	8613
TOTAL	122	209	962	6205	4233	502	351	4438	300	8613	25935
%	0.47	0.81	3.71	29.92	16.32	1.94	1.35	17.11	1.16	33.21	

ITT 7498 (28.91%)

DTT 5086 (19.61%)

ST 4738 (18.27%)

S/c 8613 (33.21%)

TT 12584 (48.52%)

I/D Ratio(3.17), i/d Ratio(2.29), PIR(6.43), TRR(59.53), TQR(62.98), CRR(40.28)

student talk initiation. In the indirect teacher talk, the percentages of tallies in categories 1, 2, 3 and 4 were 0, 1, 3 and 20 percent respectively, and in the direct teacher talk the amount of lecturing, directing and criticising, the percentages of tallies were 26, 1 and 1 respectively. The pooled matrix table yielded I/D ratio (1.46), i/d Ratio (4.74), PIR (6.58), TRR (59.09), TQR (46.87), and CCR (45.64).

Table 7b shows master matrix (10 x 10 matrix table) of 65 transitional group teacher. The total number of tallies is 25,935 for 65 observed lessons pooled together. There was 49 percent teacher talk, 18 percent pupil talk and 33 percent silence or confusion. The percentage of Indirect teacher talk and Direct teacher talk were 28.91 and 19.61 percent respectively. Out of the total student-talk there was 17 percent student talk response and only 1 percent student talk initiation. In the Indirect teacher talk percentage of tallies in categories 1, 2, 3 and 4 were 0, 1, 4 and 24 percent respectively, and in the Direct teacher-talk the percentage of tallies in categories 5, 6 and 7 were 16, 2 and 2 percent respectively. The behaviour ratios, I/D Ratio (3.17), i/d Ratio (2.29), PIR (6.43), TRR (59.52), TQR (62.98), and CCR (40.28) were obtained from the pooled matrix.

Table 8b indicates that in the formal operational group the total number of tallies was 13,167 for observation of 33 lessons pooled together. There was 53 percent teacher

TABLE 8 A

MASTER MATRIX OF FORMAL GROUP I [24X24 MATRIX TABLE]

CAT-		1	2			3			4				5	6	7			8			9			10		T	GT
			a	b	c	a	b	c	a	b	c	d	-		a	b	c	a	b	c	a	b	c	a	b		
01		8							35		1	1						17			2					64	64
2	a		23			4	2		57	2	2	6	14					7						19		136	136
	b																										
	c																										
3	a		92			68			266	6	14	28	129	9	1			3						84		700	765
	b		2				3					1		2												8	
	c		3			1		23	9			10	4											7		57	
4	a	41	1			4		1	1280		1	1	24	125	19			969		2	35	1		260	13	2777	3327
	b	2								23		1		1				7	3	2	1			2		42	
	c	1				1					90			1	5			39	1	13				14		165	
	d	4										222		11	1			35	1	57	1			11		343	
5									269	2	22	18	1410	5	2			1			7			89	2	1827	1827
6		1				5			236		5	5	23	329				102		4	1			19		730	730
7	a	1				3			59	2	4	3	8	4	20			28		1	1			20	1	155	156
	b										1															1	
	c																										
8	a	1	13			580	1		283	4	15	16	82	63	58	1		1687		1	37			73	3	2918	3145
	b		1			2	2												7	9						21	
	c		1			26		33	5			6		1	2				9	115	1			7		206	
9	a	3				4			19				6	8	36			16			31			5	1	129	131
	b																				1	1				2	
	c																										
10	a	2				2			250	3	8	23	126	166	10			7		2	11			2238		2848	2886
	b								9		2	2	1	5	1										18	38	
TOTAL		64	136			700	8	57	2777	42	165	343	1827	730	155	1		2918	21	206	129	2		2848	38	13167	
G.TOTAL		64	136			765			3327				1827	730	156			3145			131			2886	-	13167	

TABLE 8 B

10x10 MATRIX TABLE : FORMAL GROUP

CAT	1	2	3	4	5	6	7	8	9	10	TOTAL
1	8			37				17	2		64
2		23	6	67	14			7		19	136
3		97	95	334	133	11	1	3		91	765
4	48	1	6	1618	24	138	25	1129	38	300	3327
5				311	1410	5	2	1	7	91	1827
6	1		5	246	23	329		106	1	19	730
7	1		3	69	8	4	20	29	1	21	156
8	1	16	644	329	82	64	61	1828	38	83	3145
9	3		4	19	6	8	36	16	33	6	131
10	2		2	297	127	171	11	9	11	2256	2886
TOTAL	64	136	765	3327	1827	730	156	3145	131	2886	13167
%	0.4	1.03	5.81	25.26	13.87	5.54	1.18	23.88	0.99	21.92	
ITT 4292 (32.59%)					DTT 2713 (20.60%)			ST 3276 (24.88%)		S/C 2886 (21.92%)	
TT 7005 (53.20%)											

I/D Ratio (2.27), i/d Ratio (2.09), PIR (4.67), TRR (51.67), TQR (66.24), CCR (38.88)

talk, 25 percent student talk and 22 per cent silence or confusion. The percentages of Indirect teacher talk and Direct teacher-talk were 32.59, and 20.60 percent respectively. Out of the total student-talk there was 24 percent student talk response and only 1 percent student talk initiation. In the Indirect teacher talk percentages of tallies in categories 1, 2, 3 and 4 were 0, 1, 6 and 25 percent respectively, and in the Direct teacher talk the percentages of tallies in categories 5, 6 and 7 were 14, 6 and 1 percent respectively. The behaviour ratios I/D Ratio (2.27), i/d Ratio (1.09), PIR (4.67), TRR (51.67), TQR (66.24) and CCR (38.08) were obtained from the pooled matrix.

A close scrutiny of tables 6, 7 and 8 provides an interesting comparison of concrete, transitional and formal operational groups. The following observations may be noted from these tables :

1. Percentage of time spent on categories 3, 4, 6 and 8 showed clear-cut increase in formal operational group from concrete through transitional group.

2. Percentage of time spent on category 5 decreases from concrete through transitional to formal group.

3. Teacher-talk (TT), Direct-teacher-talk (DTT), teacher response ratio (TRR) and content cross ratio (CCR) showed clearcut decreasing value from concrete through transitional to formal operational group.

4. Pupil talk (PT) showed increase in value from concrete through transitional to formal group.

ORGANISATION OF FLOW DIAGRAMS

The computation of behaviour ratios and interaction variables does not reveal the structure and flow of verbal interaction. So, in order to understand the nature of teaching patterns, in terms of events, it is essential to prepare the clockwise flow diagrams and box flow diagrams of the matrices display for pooled observations of Concrete, Transitional and Formal groups. On the basis of these flows qualitative and visual interpretation can be made. Some kind of comparisons can be made with the help of flow diagrams. In order to find similarities and differences between the segments of interaction, the inferences about sequence of events can also be made on the basis of flow diagrams.

Clockwise Flow Diagram

A clockwise flow diagram provides a visual display of the chain of classroom events, which may be more acceptable for understanding the nature and structure of the classroom verbal behaviour. While preparing the clockwise flow diagrams, first the higher cell frequency of a matrix is located and circled. It will serve as a starting point. Secondly, the highest frequency on the left side of the row is marked as the next step of the flow point. The starting point is looped by an arrow to the second point. After this the third step is to locate the highest frequency

cell in the column on upward side from the second point. This will lead to the presentation of clockwise flow. When the third point is noted it is looped by the second point by an arrow. After the third point, the highest cell frequency is noted by inspecting the row towards the right side of the column and is marked by a circle. This fourth point is connected by drawing a little looping arrow from the third step. This procedure is followed for preparing the clockwise flow diagrams.

Box Flow Diagram

The clockwise flow diagrams of classroom interaction was still incomprehensible and it was possible to draw a diagram which looks just a little less complicated, and is named as a box flow diagram. It attempts to use space in ways that are proportional to the traffic pattern. The steady state pairs are drawn separately related to teacher-talk and pupil-talk. The size of steady state pairs box is proportional to the number of frequency of the cell. These boxes are connected by a looping arrow by inspecting the frequency of matrix. The thickness of connecting arrows should also be proportional to the frequencies of the cell. Thus a box flow diagram is prepared. It may be more helpful in understanding the nature and structure of verbal behaviour of the teachers.

The clockwise flow Diagrams and Box Flow Diagrams for Concrete group, Transitional group and Formal group are given in Chapter V.

CHAPTER V

INFERENTIAL DATA ANALYSIS

INTRODUCTION

This chapter deals with the discussion and interpretation of the findings by hypotheses based on the analysis of data collected on a sample of (N = 129). So this chapter has been devoted to the major analysis of data whereas the previous chapter deals with preliminary analysis of data. The major findings have been divided into two sections, namely, Chapter V : findings around behaviour patterns and behaviour ratios; Chapter VI : findings around the factorial structure of science teachers.

This section includes the inferential data analysis from hypothesis 1 to hypothesis 6. All null hypotheses have been tested at .05 level of significance.

Hypothesis 1

High-average and low creative/scientific attitude teachers do not differ in the level of their cognitive development.

Table 9A

Number of Student-teachers in 3 x 3 fold Contingency Table

Cognitive maturity	Verbal Creativity			Total
	High	Average	Low	
Concrete	8	17	6	31
Transitional	18	28	19	65
Formal	9	14	10	33
Total	35	59	35	129

The table is subjected to calculate coefficient of contingency and Chi-square. The correlation between cognitive maturity and verbal creativity was also computed. Results are given in table 9B.

Table 9B

Chi-square, coefficient of contingency and correlation between two variables maturity and verbal creativity

	Chi-square	Coefficient of contingency	Coefficient of correlation
Total Sample	129	129	129
Value	1.66	0.11	.002
Degree of freedom	4	-	127
Inference	ns	-	ns

The table shows coefficient of contingency about 0.11. Where standard error of 'C' is complex and not very satisfactory, the significance of 'C' is best tested by way of χ^2. Since our $\chi^2 = 1.66$ is not significant, our 'C' value 0.11 may be regarded as representing a negligible and insignificant relationship between cognitive maturity and verbal creativity. Similarly correlation coefficient between the two variables was found to be 0.002, which shows negligible relationship.

The findings reported, regarding the relationship between creativity and cognitive ability - like intelligence

and academic achievement - are found to be contradictory. Investigators like Getzels and Jackson (1958); Torrance (1960); Guilfor and Christensen (1956); Springbelt et al (1957); Sharma, (1972); state that to a certain extent creativity and intelligence go together, but thereafter take different directions. Similarly, Guilford (1950) has mentioned that creativity is more than intelligence and cannot be accounted for adequately in terms of I.Q. On the other hand, Paramesh (1971) shows positive correlation between creativity and intelligence.

Getzels and Jackson (1959); Torrance (1960); Cline et al (1963); and Asha (1980) emphasised that creativity and academic achievements are highly correlated. At the same time, it is also contradictory to the result obtained by Khathak (1961); Fletcher (1963); and Edward and Tyler (1965). This supports our study that cognitive maturity has got no relationship with verbal creativity.

Table 10A

Number of student-teachers in 3x3 fold Contingency Table

Cognitive maturity	Verbal Creativity			Total
	High	Average	Low	
Concrete	8	17	6	31
Transitional	20	30	15	65
Formal	7	12	14	33
Total	35	59	35	129

Contingency coefficient and Chi-square were calculated from the above 3 x 3 fold contingency table. Correlation between cognitive maturity and scientific attitude was also computed. Results are shown in table 10b.

Table 10b

Chi-square value, contingency coefficient value and correlation value between the two variables maturity and scientific attitude

	Chi-square	Coefficient of contingency	Coefficient of correlation
Total sample	129	129	129
Value	5.84	0.21	0.001
Degree of freedom	4	-	127
Inference	ns	-	ns

The table indicates 0.21 value of contingency coefficient. As standard error of 'C' is complex and not very satisfactory, hence, the significance of 'C' is best tested by way of χ^2. Since the χ^2 value 5.84 is not significant, the 'C' value 0.21 may be regarded as representing a negligible and not significant relationship between cognitive maturity and scientific attitude. Similarly, correlation value between the two is 0.001, which shows negligible relationship.

A few researchers are engaged in conducting research related to scientific attitude and their relationship to the

personality of the teacher and his achievement. Downing (1950) indicates relationship between scientific attitude and scientific thinking. While Kessler (1977) shows correlation between scientific attitude and scientific method which will be suitable for instructional purposes in secondary schools. In the present investigation no significant relationship was found by the investigator between cognitive maturity and scientific attitude.

A close scrutiny of the result obtained from tables 9 and 10 leads to the inference that the null hypothesis is true as cognitive maturity has no significant relationship with verbal creativity and scientific attitude. Hence, the hypothesis is retained as it was.

Hypothesis 2

No significant difference exists in the patterns of teaching behaviour of pupil teachers at three different levels of their cognitive maturity.

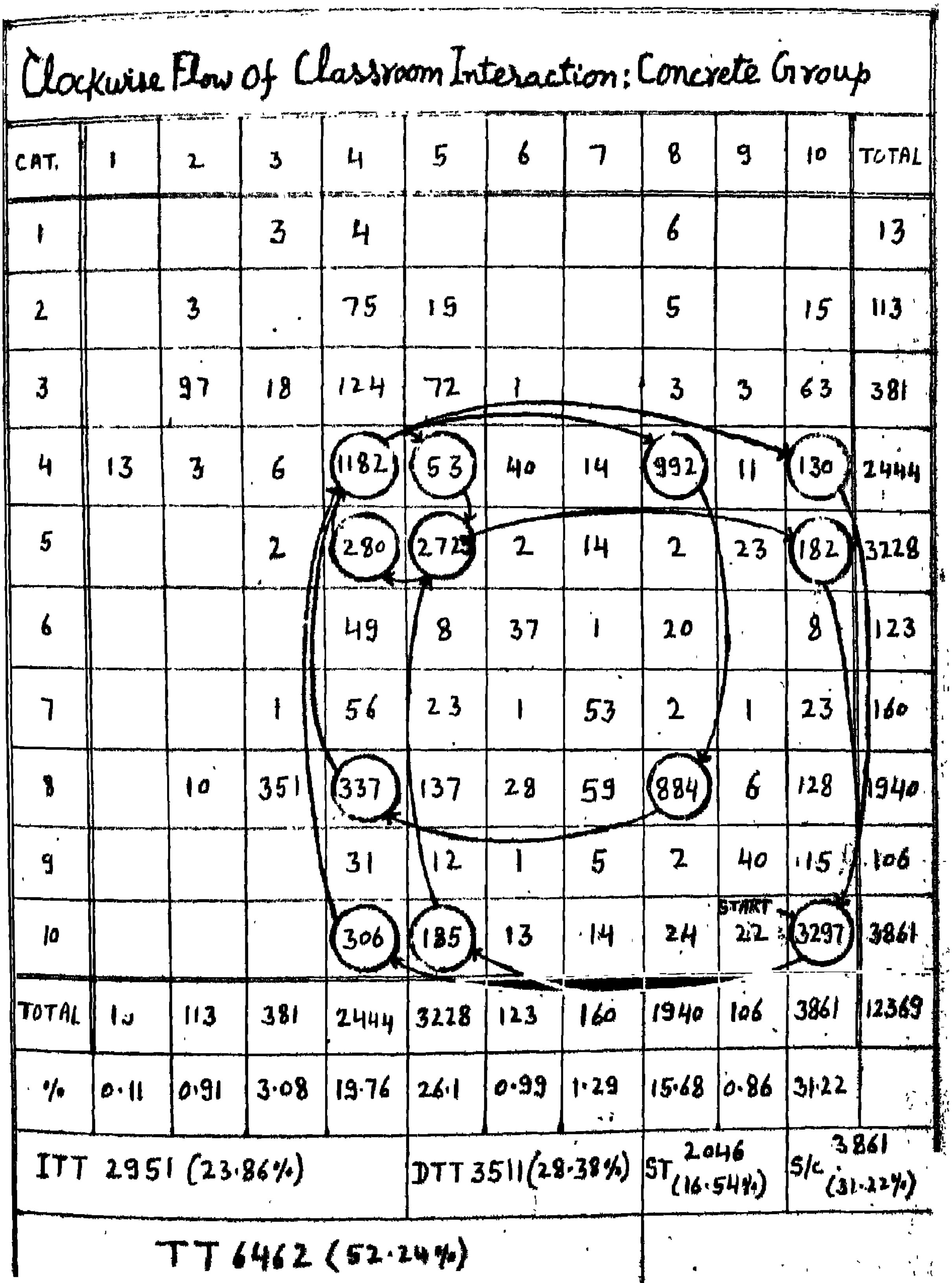
Flow of behaviour of Concrete Group

Figure 2 shows 10551 tallies in the marked cells which represent 85 percent of total tallies of the composite observation matrix. This indicates that most of the verbal interaction have been shown by circled cells and looping arrows.

The steady state cell (10-10) was noted as the starting point of classroom events as it has got highest

Fig 2

Clockwise Flow of Classroom Interaction: Concrete Group



CAT.	1	2	3	4	5	6	7	8	9	10	TOTAL
1			3	4				6			13
2		3		75	15			5		15	113
3		97	18	124	72	1		3	3	63	381
4	13	3	6	1182	53	40	14	992	11	130	2444
5			2	280	2723	2	14	2	23	182	3228
6				49	8	37	1	20		8	123
7			1	56	23	1	53	2	1	23	160
8		10	351	337	137	28	59	884	6	128	1940
9				31	12	1	5	2	40	15	106
10				306	185	13	14	24	START 22	3297	3861
TOTAL	13	113	381	2444	3228	123	160	1940	106	3861	12369
%	0·11	0·91	3·08	19·76	26·1	0·99	1·29	15·68	0·86	31·22	

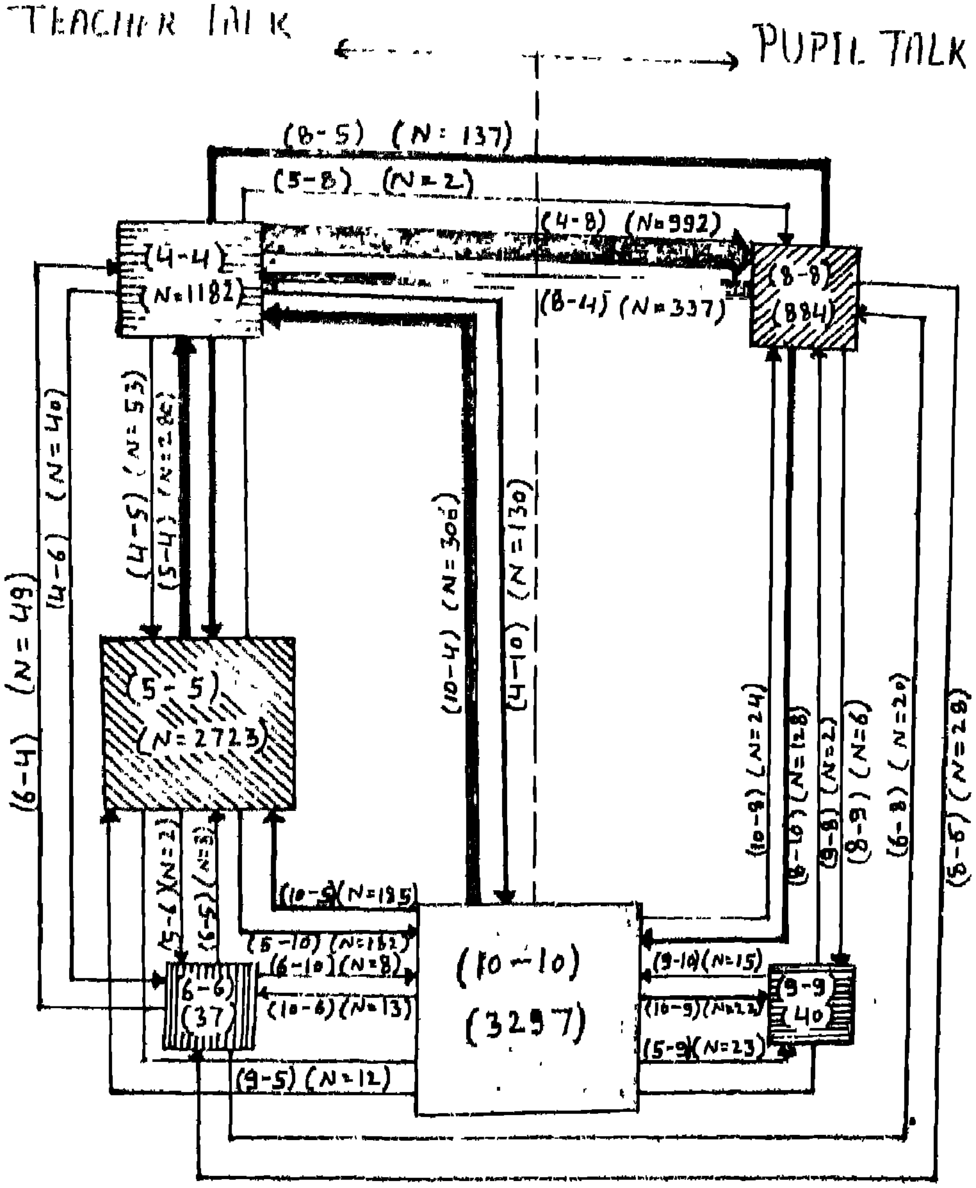
ITT 2951 (23·86%) DTT 3511 (28·38%) ST 2046 (16·54%) S/c 3861 (31·22%)

TT 6462 (52·24%)

I/D Ratio (1·46), i/d Ratio (4·74), PIR (6·58), TRR (59·09), TQR (46·87), CCR (45·84)

Fig 3

BOX FLOW DIAGRAM: CONCRETE GROUP (N=31)



frequencies in the matrix. Under one probability the silence/confusion seems to be broken down by questioning which remained in steady state (4-4) cell. The steady state of questioning had three probabilities. Firstly, it seems to be followed by pupil response. The pupil response sustained in the same situation (8-8) cell. The steady state of pupil response seems to be followed by questioning and this remains in the same state. Secondly, the steady state of questioning was followed by silence/confusion. It remained in the steady state (10-10) cell. Thirdly, the steady state of questioning seems to be followed by lecturing. It remained in the same state which was followed by questioning. Another probability of silence/confusion was likely to be followed by lecturing. It is followed by silence/confusion which sustained in the same situation. It may be observed that only first three interaction models given by Flanders were visualised from the clockwise flow diagram in figure 2. These models were, 'High content emphasis under close teacher direction', 'Teacher directed quick drill' and 'Drill combined with lecture demonstration'.

To make the clockwise flow of behaviour more comprehensible, the box flow diagram was prepared. It has been shown in figure 3. The teacher-talk and pupil talk have been marked in the form of steady state pairs and transitions of events. The (10-10) cell steady state of silence/confusion has been shown by the largest square having 3297, the highest tallies. It has 306, the heavy transitions from category 4. There were also marked

transitions from 5 and 8 categories. Hence, it is concluded that after the events of categories 4, 5 and 8 there was silence in the class. The (5-5) cell steady state of lecturing has been presented by the second largest square. There were heavy transitions from categories 4 and 8. The (4-4) cell steady state of questioning has been shown by the third largest square having largest transitions of events from category 8. It has 992, the greatest transition. The (8-8) cell steady state of pupil response has been shown by the fourth largest square. It has got heavy transitions with categories 4, 5 and 10. The (9-9) cell steady state of pupil initiation and (6-6) cell steady state of direction were the next cells having weak transitions with categories 4, 5, 8 and 10.

Flow of Behaviour of Transitional Group

Figure 4 shows 21265 tallies in the circled cells amounting to 82% of the total tallies which represents most of the verbal behaviour in the matrix. The highest frequencies steady state cell (10-10) had shown two probabilities: One being that silence/confusion was broken down by questioning. It sustained in the same situation (4-4) cell. The steady state of questioning again had three probabilities. Under the first probability it was followed by direction. The direction remained in the steady state (6-6) cell which seems tobe followed by questioning.

1.9.4

Clockwise Flow of Classroom Interaction: Transitional Group

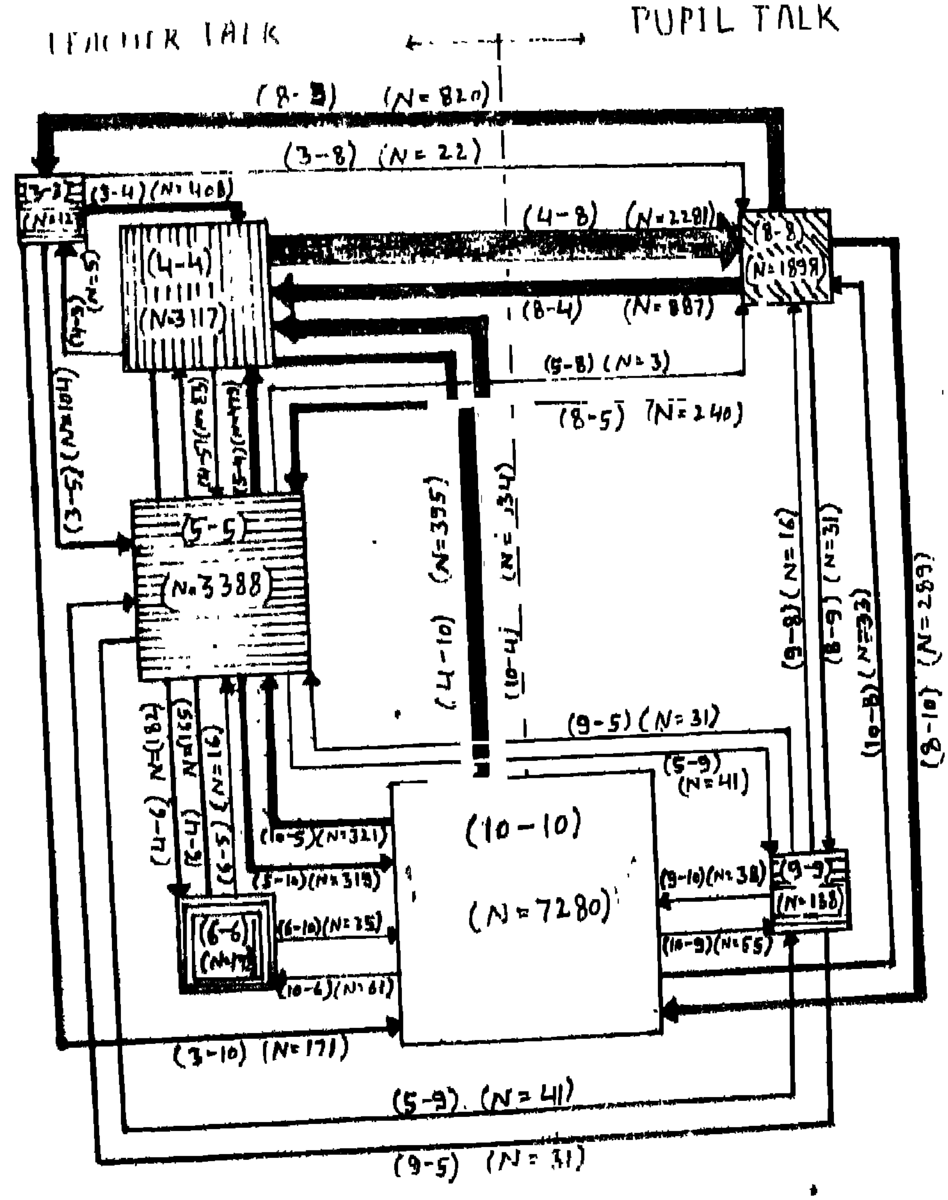
CAT.	1	2	3	4	5	6	7	8	9	10	TOTAL
1	19	1	2	46			2	48	1	3	122
2		29	2	93	21	1	1	12	2	48	209
3	2	118	127	408	104	6	1	22	3	171	962
4	90	6	5	3117	83	182	27	2281	19	395	6205
5			1	479	3388		2	3	41	319	4233
6			2	165	16	198	6	88	2	25	502
7	1		2	139	29	7	83	37	8	45	351
8	5	55	820	887	240	46	167	1898	31	289	4438
9			1	37	31	1	38	16	138	38	300
10	5			834	321	61	24	33	START 55	7280	8613
TOTAL	122	209	962	6205	4233	502	351	4438	300	8613	25935
%	0·47	0·81	3·71	23·92	16·32	1·94	1·35	17·11	1·16	33·21	

ITT 7498 (28·91%)	DTT 5086 (19·61%)	ST 4738 (18·27%)	S/C 8613 (33·21%)
TT 12584 (48·52%)			

I/D Ratio (3·17), i/d Ratio (2·29), PIR (6·43), TRR (58·53), TQR (62·98), CCR (40·28)

Fig 5

BOX FLOW DIAGRAM: TRANSITIONAL GROUP (N=65)



The questioning again entered into the steady state (4-4) cell. In the second situation the steady state of questioning was followed by pupil response, which continued for more than three seconds (8-8) cell. It seems to be followed by questioning which enterered into the steady state (4-4) cell. While in the third situation the steady state of questioning seems to be followed by silence/confusion, which sustained in the same situation (10-10) cell. On the other hand, the steady state of silence/confusion was broken down by lecturing which remained in the same situation (5-5) cell for more than three seconds. The steady state of lecturing seems to be followed by silence/confusion which sustained in the same situation (10-10) cell.

In transitional group, Flander's first four interaction models, namely 'High content emphasis under close teacher direction', 'Teacher direction quick drill' and 'Drill combined with lecture demonstration' and 'Teacher gives direction with some clarification', were apparent.

The box flow diagram figure 5, has been marked clearly in the form of steady state pairs and transition of events with regard to teacher and pupil responses. The (10-10) cell steady state of 'silence/confusion' has been shown by the largest square. It has 7280, highest tallies, and heavy transitions with categories 4, 5 and 8. The second largest square has been presented by (5-5) cell,

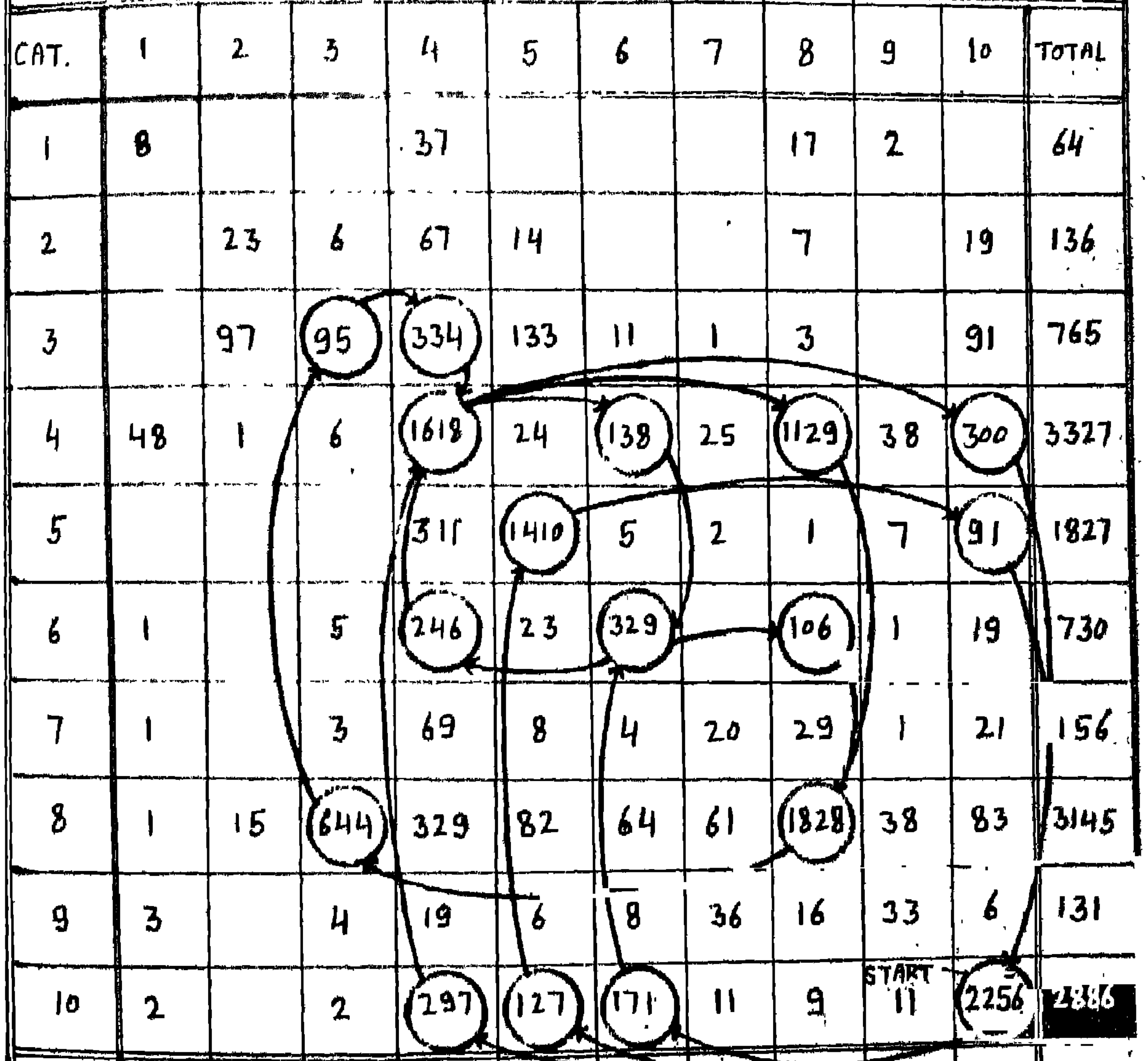
the steady state of lecturing. The heavy transitions are found with category 8 and 10. The (4-4) steady state of questioning has been shown by the third largest square. There are largest transitions from category 8. It has 2281, the greatest transitions. It also has transitions with category 3, 5 and 10. The steady state cell (8-8), (6-6), (9-9) and (3-3) has gradually been shown by the next largest squares. The (3-3) cell steady state of 'accept-ideas' has heavy transitions from student response. It indicates that after responding, the teacher accepts pupil's ideas.

Flow of Behaviour of Formal Group

Diagram 6 indicates that the starting point (10-10) cell steady state of 'silence or confusion' was interrupted by three probabilities. Under one probability it was broken down by questioning which remained in (4-4) steady state situation for more than three seconds. It has again three probabilities : One being that steady state of questioning was followed by pupil response. The pupil response sustained in the same situation (8-8) cell. The steady state of pupil response seems to be followed by 'accept ideas' which remained in the same situation (3-3) cell. The other probability of questioning was likely to be followed by direction. The direction sustained in the same situation (6-6) cell. The steady state of direction seems to be followed by questioning. Next probability for steady state of questioning seems to be followed by

Fig 6

Clockwise Flow of Classroom Interaction : Formal Group



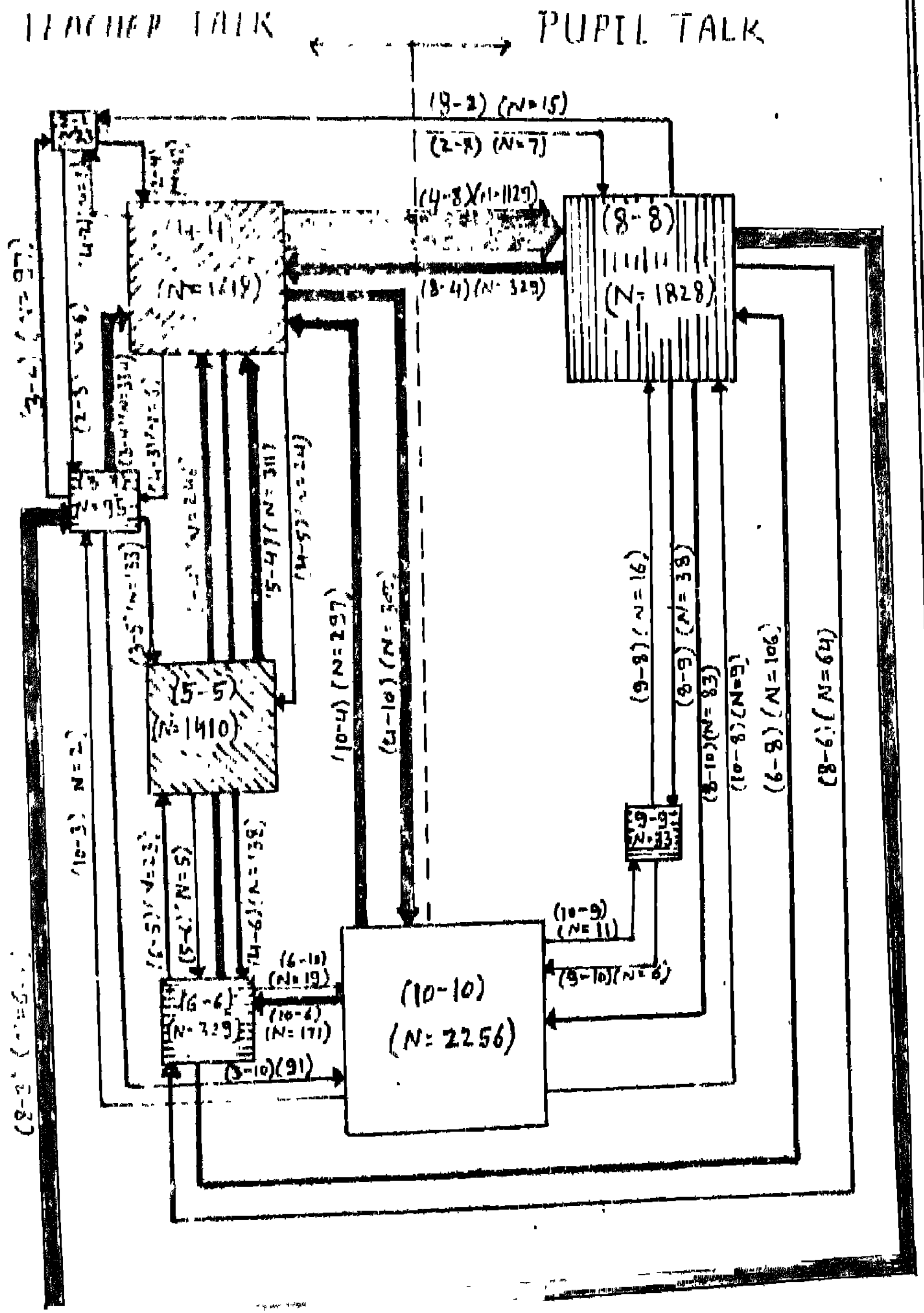
CAT.	1	2	3	4	5	6	7	8	9	10	TOTAL
1	8			37				17	2		64
2		23	6	67	14			7		19	136
3		97	95	334	133	11	1	3		91	765
4	48	1	6	1618	24	138	25	1129	38	300	3327
5				311	1410	5	2	1	7	91	1827
6	1		5	246	23	329		106	1	19	730
7	1		3	69	8	4	20	29	1	21	156
8	1	15	644	329	82	64	61	1828	38	83	3145
9	3		4	19	6	8	36	16	33	6	131
10	2		2	297	127	171	11	9	START 11	2256	2886
TOTAL	64	136	765	3327	1827	730	156	3145	131	2886	13167
%	0·4	1·03	5·81	25·26	13·87	5·54	1·18	23·88	0·99	21·92	

ITT 4292 (32·59%)	DTT 2713 (20·60%)	ST 3276 (24·88%)	S/C 2886 (21·92%)
TT 7005 (53·20%)			

I/D Ratio (2·27), i/d Ratio (2·09), PIR (4·67), TRR (51·67), TQR (66·24), CCR (38·88)

(Fig 1)

BOX FLOW DIAGRAM: FORMAL GROUP (N=33)



'silence/confusion', which continued for more than three seconds (10-10) cell. Secondly, the steady state of 'silence/confusion' was followed by lecturing which sustained there for more than three seconds (5-5) cell. The steady state of lecturing seems to be followed by silence/confusion which was followed by steady state of silence/confusion (10-10) cell. Thirdly, the silence/confusion was broken down by direction. The direction sustained in the same situation (6-6) cell. The steady state of direction seems to be followed by pupil response. This remains in the same state. The steady state of pupil response was followed by 'accept ideas', which seems to be followed by questioning.

In formal group, Flunder's interaction models, namely, 'High content emphasis under close teacher direction', 'Teacher - directed quick drill', 'Drill combined with lecture demonstration', 'Teacher gives direction with some ~~axk~~ claification', and 'Stimulating independent student thought' may be located from the flow of behaviour.

The Box flow diagram figure 7 indicates (10-10) cell steady state of silence/confusion in the form of largest square with 3026 the highest tallies. It has heavy transitions from categories 4. The (8-8) cell steady state of pupil has been shown by the second largest square. It has 1129, the greatest transitions from category 4. There were also the transitions from 3, 5 and 6, categories. The

(5-5) cell steady state of lecturing has been shown by the fourth largest square. It has transitions from 3, 4 and 6 categories. The other cells which showed decreasing size of the steady state squares are (6-6), (3-3) and (2-2) respectively. The (2-2) cell steady state of 'praise' has transitions from categories 3 and 8, whereas (3-3) cell steady state of 'accept ideas' has significant transitions from category 8. This indicated that formal 'teacher accepts student's ideas' and praises them. Comparison of flow of behaviour of Concrete, Transitional and Formal group.

The clockwise flow diagram (figures 2, 4, 6) of three groups were compared and the following conclusions were drawn :

1. There were 10551, 21265 and 11119 tallies for concrete, transitional and formal groups in the circled cells. These represent 85%, 82% and 84% of the total tallies in the groups respectively.

2. The (10-10) cell steady state of silence/confusion was starting point in all three groups.

3. The steady state of silence/confusion (10-10), in concrete and transitional group was broken down by questioning or lecturing by the teacher, whereas in addition to these, direction was also used in interrupting the (10-10) cell by formal group.

4. The flow of behaviour is more or less similar in concrete and transitional group except that ransitional teachers used direction. Whereas in

addition to transitional, formal group, teachers showed a trait of using 'accept ideas and praise'. The category 3 and 2 respectively.

It may be further noted that Flander's first three interaction models namely 'High content emphasis under close teacher direction', 'Teacher-directed quick drill' and 'Drill combined with lecture demonstration' appeared in Concrete group, in addition to this the model 'Teacher gives direction with some clarification', appeared in Transitional group, in addition to the transitional models the 'Stimulating independent student thought', was seen in formal group.

The box flow diagrams (figures 3, 5 and 7) of roups were compared and the following conclusions awn :

An inspection of the box flow diagrams of three groups reveals that in all three groups, the steady state of silence/confusion (10-10) cell have been presented by the largest squares.

The steady state (5-5), (4-4), (8-8) cells in Concrete and Transitional groups have been presented by the gradual decrease in the size of squares, which can be named as second, third and fourth largest squares of the groups.

The steady state (2-2) also appeared in Formal group. It has got transitions from categories 3 and 8.

The heavy transitions were observed on (8-8) cell from (4-4) cell in all the groups.

Transitional and Formal groups showed heavy transitions on (3-3) cell steady state of accept ideas from steady state of pupil response (8-8) cell. In addition to this Formal group also showed the use of (2-2) cell steady state of praise. It had transitions from categories 3 and 8.

esis 3

No significant difference exists in -

High-average and low-creative teachers at Concrete/Transitional/and Formal level.

High/average/and low creative teachers at Concrete-Transitional-and Formal level.

With respect to 11 behaviour ratios (TT, ITT, DTT, PT, S/C, I/D, i/d, PIR, TRR, TQR and CCR).

'A' portion of the hypothesis is shown in table 11, d 13, while 'B' part is interpreted with the help of 5 and 16 tables.

By scrutinising tables 11, 12 and 13, the following sions can be drawn :

Table 11 reveals that the high-average and low creative teachers do not differ on all interaction variables at Concrete level, as no behaviour ratio reached to the level of significance.

It will be seen from table 12 that no significant difference in the interaction patterns featuring the high, average and low creative teachers at transitional level, was observed as all 'F' values were insignificant.

Table 11

'F' values of 11 behaviour ratios of high-average and low creative teachers at concrete level

S. No.	Inter-action vari-able	Source of variance	Sum of square	Degree of free-dom	Mean square	F	Re-sult
1.	TT	Between the group	282.625	2	141.315	.84	ns
		Within the group	4687.375	28	167.406		
2.	ITT	Between the group	57.246	2	28.623	.59	ns
		Within the group	1370.957	28	48.963		
3.	DTT	Between the group	456.852	2	228.426	1.09	ns
		Within the group	5868.711	28	209.597		
4.	PT	Between the group	79.801	2	39.901	1.29	ns
		Within the group	868.977	28	31.035		
5.	S/C	Between the group	266.074	2	133.037	.68	ns
		Within the group	5459.356	28	194.977		
6.	I/D	Between the group	3.798	2	1.899	.72	ns
		Within the group	73.944	28	2.641		
7.	i/d	Between the group	144.462	2	72.231	2.20	ns
		Within the group	921.475	28	32.910		
8.	PIR	Between the group	77.174	2	38.587	.48	ns
		Within the group	2274.376	28	81.228		
9.	TRR	Between the group	1921.500	2	960.750	.92	ns
		Within the group	29415.250	28	1050.544		
10.	TQR	Between the group	1452.938	2	726.469	1.98	ns
		Within the group	10290.625	28	367.522		
11.	CCR	Between the group	269.219	2	134.609	.79	ns
		Within the group	4746.992	28	169.535		

ns - not significant at .05 level

Table 12

'F' values of 11 behaviour ratios of high-average and low creative teachers at transitional level

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	Between the group	118.500	2	59.250	.39	ns
		Within the group	9425.375	62	152.022		
2.	ITT	Between the group	45.441	2	22.721	.26	ns
		Within the group	5474.816	62	88.304		
3.	LTT	Between the group	63.090	2	31.545	.23	ns
		Within the group	8586.051	62	138.485		
4.	PT	Between the group	62.344	2	31.172	.85	ns
		Within the group	2282.813	62	36.420		
5.	S/C	Between the group	532.375	2	266.188	1.34	ns
		Within the group	12346.688	62	199.140		
6.	I/D	Between the group	71.263	2	35.631	1.34	ns
		Within the group	1653.876	62	26.675		
7.	i/d	Between the group	8.787	2	4.394	.37	ns
		Within the group	732.659	62	11.817		
8.	PIR	Between the group	33.043	2	11.521	.22	ns
		Within the group	4960.895	62	80.014		
9.	TRR	Between the group	162.563	2	81.281	.176	ns
		Within the group	28709.688	62	463.059		
10.	TQR	Between the group	337.313	2	168.656	.34	ns
		Within the group	31081.750	62	501.318		
11.	CCR	Between the group	65.875	2	32.938	.21	ns
		Within the group	9793.188	62	157.955		

ns - not significant at .05 level

Table 13

'F' Values of 11 behaviour ratio of high-average and low creative teachers at formal level

S. No.	Inter-action vari-able	Source of variance	Sum of square	Degree of free-dom	Mean square	F	Re-sult
1.	TT	Between the group	3.750	2	1.875	.02	ns
		Within the group	3377.188	30	112.573		
2.	ITT	Between the group	296.012	2	148.006	3.14	ns
		Within the group	1414.543	30	47.151		
3.	DTT	Between the group	252.652	2	126.326	1.24	ns
		Within the group	3057.602	30	101.920		
4.	PT	Between the group	339.020	2	169.510	1.57	ns
		Within the group	3238.500	30	107.950		
5.	L/C	Between the group	357.434	2	178.717	.79	ns
		Within the group	6791.539	30	226.385		
6.	I/D	Between the group	4.723	2	2.362	1.08	ns
		Within the group	65.822	30	2.194		
7.	i/d	Between the group	37.415	2	18.707	.88	ns
		Within the group	635.313	30	21.177		
8.	PIR	Between the group	18.463	2	9.232	.31	ns
		Within the group	904.870	30	30.163		
9.	TRR	Between the group	356.063	2	178.031	.49	ns
		Within the group	10749.313	30	358.310		
10.	TQR	Between the group	2115.500	2	1057.750	3.34	Sig.
		Within the group	9490.625	30	316.354		
11.	CCR	Between the group	92.891	2	46.445	.45	ns
		Within the group	3086.633	30	102.888		

ns - not significant at .05 level

Sig.- Significant at .05 level

Table 13 depicts that only one interaction variable - T.R becomes significant. Ten out of eleven interaction variables show no significant difference among high, average and low creative teachers at formal level. For this interaction variable, the group high creative and average creative shows .017 insignificant 't' value. Whereas groups average creative - low creative, high creative, high creative - low creative shows 2.13 and 2.38 significant 't' values respectively.

Therefore, overall, it may be concluded that levels creativity have got no relationship with levels of nitive maturity with respect to behaviour ratios.

By paying deep insight to 14, 15 and 16 tables following conclusions were drawn :

The Table 14 supports that the significant difference in respect of interaction variables that marked the concrete-transitional and formal groups persist for ITT, PT and S/C. Eight out of eleven interaction variables show insignificant difference for the three groups (Concrete-Transitional and Formal high creative).

Contd.

Table 14

'F' values of 11 behaviour ratios of concrete-transitional and formal high creative teachers

S. No.	Inter-action variable	Source of variance	Sum of square	Degree of free-dom	Mean square	F	Re-sult
1.	TT	Between the group	256.750	2	128.375	.75	ns
		Within the group	5506.000	32	172.063		
2.	ITT	Between the group	365.434	2	182.717	3.48	sig.
		Within the group	1678.457	32	52.452		
3.	DTT	Between the group	236.055	2	118.027	.76	ns
		Within the group	4945.492	32	154.547		
4.	PT	Between the group	1002.504	2	501.252	10.98	Sig.
		Within the group	1461.051	32	45.658		
5.	D/C	Between the group	2167.297	2	1083.648	4.79	Sig.
		Within the group	7228.887	32	225.903		
6.	I/D	Between the group	2.574	2	1.287	.24	ns
		Within the group	169.597	32	5.299		
7.	i/d	Between the group	194.796	2	97.398	2.38	ns
		Within the group	1309.375	32	40.918		
8.	PIR	Between the group	10.668	2	5.334	.13	ns
		Within the group	1372.875	32	42.902		
9.	TRR	Between the group	334.313	2	167.156	.23	ns
		Within the group	23318.438	32	728.701		
10.	TQR	Between the group	1303.375	2	651.688	1.62	ns
		Within the group	12905.250	32	403.289		
11.	CCR	Between the group	309.852	2	154.926	.93	ns
		Within the group	5346.559	32	167.080		

ns - not significant at .05 level

Sig. - Significant at .05 level

Table 15

'F' Values of 11 behaviour ratio of concrete-transitional and formal average creative teachers

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	Between the group	306.875	2	153.438	1.08	ns
		Within the group	7991.750	56	142.709		
2.	ITT	Between the group	1024.973	2	512.486	6.61	Sig.
		Within the group	4340.781	56	77.514		
3.	DTT	Between the group	855.066	2	427.533	2.96	ns
		Within the group	8093.934	56	144.535		
4.	PT	Between the group	406.652	2	203.326	3.89	Sig.
		Within the group	2923.766	56	52.210		
5.	S/C	Between the group	1248.348	2	624.164	2.87	ns
		Within the group	12162.887	56	217.194		
6.	I/D	Between the group	91.226	2	45.613	1.62	ns
		Within the group	1574.164	56	28.110		
7.	i/d	Between the group	12.376	2	6.188	.43	ns
		Within the group	808.336	56	14.435		
8.	PIR	Between the group	114.233	2	57.116	.59	ns
		Within the group	5417.426	56	96.739		
9.	TRR	Between the group	148.250	2	74.125	.12	ns
		Within the group	34942.688	56	623.966		
10.	TQR	Between the group	4901.563	2	2450.781	5.28	Sig
		Within the group	25996.250	56	464.219		
11.	CCR	Between the group	300.875	2	150.438	1.13	ns
		Within the group	7471.938	56	133.427		

ns - not significant at .05 level

Sig. - Significant at .05 level

Table 16

'F' Values of 11 behaviour ratios of concrete-transitional and formal low creative teachers

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	Between the group	282.500	2	141.250	1.13	ns
		Within the group	3992.250	32	124.758		
2.	ITT	Between the group	251.676	2	125.838	1.79	ns
		Within the group	2241.078	32	70.034		
3.	DTT	Between the group	1048.957	2	524.479	3.75	Sig.
		Within the group	4472.938	32	139.779		
4.	PT	Between the group	209.277	2	104.639	1.67	ns
		Within the group	2005.473	32	62.671		
5.	S/C	Between the group	107.359	2	53.679	.33	ns
		Within the group	5205.793	32	162.681		
6.	I/D	Between the group	6.805	2	3.403	2.18	ns
		Within the group	49.881	32	1.559		
7.	i/d	Between the group	90.666	2	45.333	8.45	Sig.
		Within the group	171.734	32	5.367		
8.	PIR	Between the group	46.966	2	23.453	.56	ns
		Within the group	1349.837	32	42.182		
9.	TRR	Between the group	3173.688	2	1586.844	4.79	Sig.
		Within the group	10613.125	32	331.660		
10.	TQR	Between the group	3185.438	2	1592.719	4.26	Sig.
		Within the group	11961.563	32	373.798		
11.	CCR	Between the group	496.125	2	248.063	1.65	ns
		Within the group	4808.313	32	150.259		

ns - not significant at .05 level

Sig. - Significant at .05 level

Table 17

't' values and its significance of significant 'F' ratios of table 14

Group	Interaction variables		
	ITT	PT	S/C
Concrete-Transitional high creative	0.34 ns	0.47 ns	0.72 ns
Transitional-formal high creative	1.60 ns	3.23 S	2.17 S
Concrete-formal high creative	1.58 ns	2.18 S	1.11 ns

No significant 't' value was obtained in table 17 for ITT interaction variable which shows 34, 1.60 and 1.58 for concrete-transitional high creative group, transitional - formal high creative group and concrete-formal high creative group respectively. While for PT interaction variable, the group concrete-transitional creative shows 0.47 insignificant, transitional - formal creative 3.23 significant and concrete-formal creative group 2.18 significant 't' values. The S/C interaction variable shows 0.72 and 1.11 insignificant 't' values for concrete-transitional and concrete-formal high creative group respectively. On the other hand a significant 't' 2.17 was obtained for transitional formal creative group.

2. Table 15 reveals significant 'F' value for ITT, PT and T.R for concrete-transitional and formal average

creative group. Table 18 shows that for ITT 6.68 and 3.63 't' values were found significant in concrete - transitional average creative group and concrete-formal average creative groups respectively. Whereas transitional-formal average creative group shows 1.94 insignificant 't' value.

Table 18

't' values of significant 'F' ratios of table 15

oup	Interaction variable		
	ITT	PT	TQR
ncrete-transitional erage creative	6.68 S	2.94 S	8.04 S
ansitional-formal erage creative	1.94 ns	2.09 S	0.04 ns
ncrete-formal erage creative	3.63 S	2.74 S	3.03 S

All three, the concrete-transitional average creative, transitional formal average creative and concrete-formal average creative, groups show significant 't' values 2.94, 2.09 and 2.74 respectively, for PT interaction variable. Similarly 't' values 8.04 and 3.03 were found to be significant for concrete-transitional average creative and concrete-formal average creative group with respect to TQR. On the other hand, 0.85 't' value was found to be insignificant for transitional-formal average creative group on the same variable.

3. Table 16 states significant 'F' values for DTT, 1/d, TRR and TwR interaction variables. While other behaviour ratios show insignificant 'F' values in concrete-transitional and formal low creative group. Table 19 shows significant 't' value 2.73 and 2.91 on DTT and TwR in concrete-transitional low creative group. While 't' values 0.80 and 1.87 on DTT and 0.82 and 2.02 on TwR interaction variable was found to be insignificant for transitional-formal low creative and concrete-formal low creative groups.

The 1/d interaction variable shows 3.51 significant, 1.00 insignificant and 3.91 significant 't' values for concrete-transitional low creative, transitional-formal low creative and concrete-formal low creative groups.

Table 19

't' values of significant 'F' ratios of table 16

Group	Interaction variable			
	DTT	1/d	TRR	TwR
Concrete-transitional low creative	2.73 S	3.51 S	1.62 ns	2.91 S
Transitional-formal low creative	0.80 ns	1.00 ns	2.06 S	0.82 ns
Concrete-formal low creative	1.87 ns	3.91 S	3.01 S	2.02 ns

The TRR behaviour ratio shows 1.62 insignificant 't' value for concrete-transitional low creative group. Whereas significant 't' values 2.06 and 3.01 were obtained in transitional-formal low creative and concrete-formal low creative group respectively.

thesis 4

No significant difference exists in -

High-average and low scientific attitude teachers at concrete/transitiona/and formal level.

High/average/and low scientific attitude teachers at concrete-transitional/and formal level.

With respect to 11 behaviour ratios. (TT, ITT, DTT, PT, S/C, I/D, i/d, PIR, TRR, TQR, CCR). Portion 'A' is interpreted by tables 20, 21 and 22 while part 'B' is interpreted by 24, 25 and 26 tables.

Contd.

Table 20

'F' Values of 11 behaviour ratios of High-average and low scientific attitude teachers at Concrete level

S. No.	Inter-action vari-able	Source of variance	Sum of square	Degree of free-dom	Mean square	F	Re-sult
1.	TT	Between the group	173.563	2	86.781	.51	ns
		Within the group	4796.438	28	171.301		
2.	ITT	Between the group	69.727	2	34.863	.72	ns
		Within the group	1358.477	28	48.517		
3.	DTT	Between the group	369.102	2	184.551	.87	ns
		Within the group	5956.461	28	212.731		
4.	PT	Between the group	89.469	2	44.734	1.46	ns
		Within the group	859.309	28	30.690		
5.	S/C	Between the group	20.121	2	10.061	.05	ns
		Within the group	5705.309	28	203.761		
6.	I/D	Between the group	0.173	2	0.087	.03	ns
		Within the group	77.569	28	2.770		
7.	i/d	Between the group	46.984	2	23.492	.65	ns
		Within the group	1018.951	28	36.391		
8.	PIR	Between the group	158.166	2	79.083	1.01	ns
		Within the group	2193.383	28	78.335		
9.	TRR	Between the group	345.563	2	172.781	.16	ns
		Within the group	30991.188	28	1106.828		
10.	TQR	Between the group	476.438	2	238.219	.60	ns
		Within the group	11267.125	28	404.397		
11.	CCR	Between the group	215.086	2	107.543	.63	ns
		Within the group	4801.125	28	171.469		

ns - not significant at .05 level

Table 21

'F' Values of 11 behaviour ratios of High-average and low scientific attitude teachers at Transitional level

S. No.	Inter-action variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	Between the group	1075.250	2	537.625	3.94	Sig.
		Within the group	8468.625	62	136.591		
2.	ITT	Between the group	19.781	2	9.891	.11	ns
		Within the group	5500.477	62	88.717		
3.	DTT	Between the group	1003.078	2	501.539	4.07	Sig.
		Within the group	7646.063	62	123.324		
4.	PT	Between the group	65.395	2	32.697	.89	ns
		Within the group	2279.762	62	36.770		
5.	S/C	Between the group	602.438	2	301.218	1.52	ns
		Within the group	12276.625	62	198.010		
6.	I/D	Between the group	15.221	2	7.611	.28	ns
		Within the group	1709.917	62	27.579		
7.	i/d	Between the group	36.346	2	18.173	1.59	ns
		Within the group	705.100	62	11.373		
8.	PIR	Between the group	29.388	2	14.694	.18	ns
		Within the group	4966.547	62	80.106		
9.	TRR	Between the group	239.313	2	119.656	.26	ns
		Within the group	28632.938	62	461.822		
10.	TwR	Between the group	3898.688	2	1949.344	4.39	Sig.
		Within the group	27520.375	62	443.877		
11.	CCR	Between the group	1238.563	2	619.281	4.45	Sig.
		Within the group	8620.501	62	139.040		

ns - not significant at .05 level
Sig. - Significant at .05 level

Table 22

'F' values of 11 behaviour ratios of High-average and low scientific attitude teachers at formal level

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean Square	F	Result
1.	TT	between the group	201.313	2	100.656	.95	ns
		within the group	3179.625	30	105.988		
2.	ITT	between the group	49.089	2	24.545	.44	ns
		Within the group	1661.465	30	55.382		
3.	DTT	Between the group	443.645	2	221.822	2.32	ns
		within the group	2866.609	30	95.554		
4.	PT	between the group	15.664	2	7.832	.07	ns
		Within the group	3561.856	30	118.729		
5.	S/C	Between the group	247.609	2	123.805	.54	ns
		Within the group	6901.363	30	230.045		
6.	I/D	Between the group	7.915	2	3.957	1.89	ns
		Within the group	62.631	30	2.088		
7.	i/d	between the group	20.096	2	10.048	.46	ns
		Within the group	652.631	30	21.754		
8.	PIR	between the group	4.024	2	2.012	.07	ns
		Within the group	919.309	30	30.644		
9.	TRR	between the group	98.063	2	49.031	.14	ns
		Within the group	11007.313	30	366.910		
10.	TQR	between the group	1905.500	2	952.750	2.95	ns
		Within the group	9700.625	30	323.354		
11.	CCR	Between the group	358.125	2	179.063	1.91	ns
		Within the group	2821.398	30	94.047		

ns - not significant at .05 level

By looking into tables 20, 21 and 22 the following conclusions have been drawn :

(1) Table 20 shows that high-average and low scientific attitude teachers do not differ on all interaction variables at concrete level as no 'F' value reached to the level of significance.

(2) Table 21 reveals that except TT, DTT, TqR and CCR interaction variables other interactive variables show insignificant difference between high-average and low-scientific attitude teachers at transitional level as only four 'F' seem to be significant. The 't' values for significant 'F' values is given below :

Table 23

't' values of significant 'F' ratios of table 21

Group	Interaction variable			
	DDT	i/d	TRR	TqR
Transitional high and average scientific attitude	1.11 ns	0.79 ns	1.35 ns	1.32 ns
Transitional average and low scientific attitude	1.16 ns	1.94 ns	1.59 ns	1.65 ns
Transitional high and low scientific attitude	2.80 S	2.84 S	2.95 S	2.98 S

That only transitional high and low scientific attitude groups showed significant 't' as 2.80, 2.84, 2.95 and 2.98 on TT, DTT, TqR and CCR respectively.

Table 24

'F' values of 11 behaviour ratios of concrete-transitional and formal high scientific attitude teachers

S. No.	Inter-action vari-able	Source of variance	Sum of square	Degree of free-dom	Mean square	F	Re-sult
1.	TT	between the group	324.375	2	162.186	.95	ns
		Within the group	5487.625	32	171.488		
2.	ITT	between the group	520.262	2	260.131	2.59	ns
		Within the group	3218.145	32	100.567		
3.	DTT	between the group	1390.238	2	695.119	4.50	Sig
		Within the group	4939.316	32	154.354		
4.	PT	between the group	345.285	2	172.643	2.83	ns
		Within the group	1952.269	32	61.008		
5.	S/C	Between the group	521.106	2	260.553	1.09	ns
		Within the group	7618.453	32	238.077		
6.	I/D	between the group	7.736	2	3.868	.69	ns
		Within the group	179.807	32	5.619		
7.	i/d	Between the group	128.057	2	64.029	5.44	Sig
		Within the group	376.915	32	11.779		
8.	PIR	Between the group	134.007	2	67.004	1.06	ns
		Within the group	2020.165	32	63.130		
9.	TRR	Between the group	434.875	2	217.438	.36	ns
		Within the group	19148.125	32	598.379		
10.	TQR	Between the group	2962.375	2	1481.188	2.89	ns
		Within the group	16427.938	32	513.373		
11.	CCR	Between the group	839.78	2	419.889	3.35	Sig.
		Within the group	4014.113	32	125.441		

ns - not significant at .05 level

Sig. - Significant at .05 level

Table 25

'F' values of 11 behaviour ratios of concrete-transitional formal average scientific attitude teachers

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	between the group	591.813	2	295.906	2.29	ns
		within the group	7241.188	56	129.307		
2.	ITT	between the group	590.824	2	295.412	5.45	Sig.
		Within the group	3034.996	56	54.196		
3.	DTT	Between the group	1238.309	2	619.154	4.81	Sig.
		within the group	7213.742	56	128.817		
4.	PT	between the group	455.977	2	227.988	4.57	Sig.
		Within the group	2796.602	56	49.939		
5.	S/C	between the group	1012.793	2	506.397	2.57	ns
		Within the group	11035.789	56	197.068		
6.	I/D	between the group	39.583	2	19.792	1.86	ns
		within the group	594.519	56	10.616		
7.	i/d	between the group	107.377	2	53.689	4.25	Sig.
		Within the group	706.335	56	12.631		
8.	PIR	Between the group	50.499	2	25.249	.49	ns
		Within the group	2860.416	56	51.079		
9.	TRR	Between the group	587.563	2	293.781	.51	ns
		Within the group	32260.750	56	576.085		
10.	TQR	between the group	6371.125	2	3185.563	8.56	Sig.
		within the group	20829.813	56	371.961		
11.	CCR	Between the group	829.750	2	414.875	2.90	ns
		Within the group	8010.813	56	143.050		

ns - not significant at .05 level

Sig. - Significant at .05 level

Table 26

'F' values of 11 behaviour ratios of concrete-transitional formal low scientific attitude teachers

S. No.	Inter-action vari-able	Source of variance	Sum of square	Degree of freedom	Mean Square	F	Re-result
1.	TT	Between the group	218.813	2	109.406	.94	ns
		Within the group	3715.938	32	116.123		
2.	ITT	Between the group	291.703	2	145.852	2.06	ns
		Within the group	2267.277	32	70.853		
3.	DTT	Between the group	30.336	2	15.168	.12	ns
		Within the group	4316.074	32	134.877		
4.	PT	Between the group	529.839	2	264.919	4.34	Sig.
		Within the group	1952.055	32	61.002		
5.	S/C	Between the group	999.941	2	499.971	2.57	ns
		Within the group	6229.039	32	194.658		
6.	I/D	Between the group	34.895	2	17.448	.52	ns
		Within the group	1075.791	32	33.619		
7.	i/d	Between the group	3.738	2	1.869	.05	ns
		Within the group	1292.434	32	40.389		
8.	PIR	Between the group	79.738	2	39.869	.40	ns
		Within the group	3198.662	32	99.958		
9.	TRR	Between the group	519.313	2	259.656	.43	ns
		Within the group	19222.625	32	600.707		
10.	TQR	Between the group	803.250	2	401.625	1.15	ns
		Within the group	11230.375	32	350.942		
11.	CCR	Between the group	177.438	2	88.719	.67	ns
		Within the group	4218.125	32	131.816		

ns - not significant at .05 level

Sig. - Significant at .05 level

(3) Table 22 depicts that the high-average and low scientific attitude teachers do not differ on any interaction variable at formal level as no 'F' ratio reached to the level of significance.

By observing tables 24, 25 and 26 the following conclusions were drawn :

(1) Table 24 seems to indicate that the insignificant difference in the interaction variables featuring the concrete-transitional and formal high scientific attitude were obtained. Only three interaction variables DDT, i/d and CCR become significant. The 't' values for significant variables are given below:

Table 27

't' values of significant 'F' ratios of table 24

Group	Interaction variable		
	DTT	i/d	CCR
Concrete-trancitional high scientific attitude	2.91 s	2.99 s	2.02 ns
Transitional-formal high scientific attitude	0.15 ns	0.51 ns	0.99 ns
Concrete-formal high scientific attitude	2.23 s	2.85 s	2.47 s

Table 27 reveals 2.91 and 2.99 significant 't' values on DTT and i/d interaction variable respectively in concrete-transitional high-scientific attitude group. Whereas for this group become insignificant 2.02 on CCR. The

transitional formal high scientific attitude groups do not show any significant 't' value for these variables. While concrete-formal high scientific attitude groups show significant 't' values 2.23, 2.85 and 2.47 on DTT, 1/d and CCR interaction variables respectively.

(2) An examination of table 25 reveals that five interaction variables namely ITT, DTT, PT, 1/d and T+R reached to the level of significance in concrete-transitional and formal average scientific attitude group.

The 't' values for significant variables are given below :

Table 28

't' values of significant 'F' ratios of table 25

Group	Interaction variable				
	ITT	DTT	PT	1/d	T+R
Concrete-transitional average scientific attitude	1.47 ns	2.94 S	1.05 ns	2.70 S	3.56 S
Transitional-formal average scientific attitude	2.24 S	0.08 ns	2.40 S	0.24 ns	0.97 ns
Concrete-formal average scientific attitude	3.36 S	2.46 S	2.98 S	2.42 S	3.75 S

Table 28 shows significant 't' values 2.94, 2.70 and 3.56 on DTT, 1/d and T+R respectively for concrete transitional average scientific attitude group. On the other hand, only ITT and PT interaction variables showed 't' values 2.24 and

Table 29

'F' values of 11 behaviour ratios among concrete-transitional and formal operationalteachers

S. No.	Interaction variable	Source of variance	Sum of square	Degree of freedom	Mean square	F	Result
1.	TT	Between the group	615.063	2	307.531	2.17	ns
		Within the group	17894.813	126	142.022		
2.	ITT	Between the group	1270.000	2	635.000	9.24	sig.
		Within the group	8659.063	126	68.723		
3.	DTT	Between the group	1714.957	2	857.479	5.91	Sig.
		Within the group	18284.957	126	145.119		
4.	PT	Between the group	1282.707	2	641.354	11.76	Sig.
		Within the group	6871.453	126	54.535		
5.	E/C	Between the group	2804.063	2	1402.031	6.86	Sig.
		Within the group	25753.500	126	204.393		
6.	I/D	Between the group	62.667	2	31.333	2.11	ns
		Within the group	1873.427	126	14.869		
7.	i/d	Between the group	150.139	2	75.069	3.82	sig.
		Within the group	2480.109	126	19.683		
8.	PIR	Between the group	81.148	2	40.574	.62	ns
		Within the group	8270.824	126	65.641		
9.	TRR	Between the group	1466.938	2	733.469	1.30	ns
		Within the group	11314.375	126	565.987		
10.	TQR	Between the group	7208.000	2	3604.000	8.29	sig.
		Within the group	54768.750	126	434.673		
11.	CCR	Between the group	899.688	2	449.844	3.14	Sig.
		Within the group	18054.875	126	143.293		

ns - not significant at .05 level

Sig. - Significant at .05 level

2.40 significant in transitional formal average scientific attitude groups respectively. While no interaction variable showed insignificant 't' value for concrete-formal average scientific attitude group.

(3) Table 2b reveals that only one of the interaction variables reached to the level of significance in concrete transitional and formal low scientific attitude group. The significant 'F' for PT, gave one significant 't' value for transitional-formal low scientific attitude group which is 2.07.

Hypothesis 5

No significant difference exists among concrete, transitional and formal group teachers with respect to 11 behaviour ratios. (TT, ITT, DTT, PT, E/C, I/D, i/d, PIR, TRR, TQR and CCR).

A close scrutiny of table 29 gives the following conclusions :

(1) It shows that the groups - concrete-transitional and formal operational teachers differ significantly on seven, out of 11 interaction variables. The significant 'F' values were obtained for ITT, DTT, PT, E/C, i/d, TQR and CCR. So this null hypothesis was not accepted and it is likely to be rejected.

The 't' values for significant variables are given below :

Table 30

't' values of significant 'F' ratios of table 29

Group	Interaction Variable ITT	DTT	PT	S/C	1/d	T4R	CCR
Concrete-transitional	8.47 S	10.34 S	3.25 S	1.87 ns	7.90 S	10.95 S	6.54 S
Transitional-formal	13.89 S	08.49 S	14.38 S	8.34 S	7.79 S	11.96 S	7.48 S
Concrete-formal	6.50 S	01.04 ns	11.42 S	11.04 S	0.59 ns	02.22 S	1.65 S

Table 30 indicates that all, except one, significant 't' values were obtained in concrete-transitional group. The values of 't' for ITT, DTT, PT, 1/d, T4R and CCR were found to be 8.47, 10.34, 3.25, 7.90, 10.95 and 6.54 respectively. The insignificant 't' value for S/C was 1.87.

No insignificant 't' value was found in transitional-formal group. The interaction variables - ITT, DTT, PT, S/C, 1/d, T4R and CCR showed 13.89, 8.49, 14.38, 8.34, 7.79, 11.96 and 7.48 highly significant 't' values in the group.

It was further interpreted that the interaction variables DTT 1/d and CCR showed insignificant 't' values in the concrete-formal group. The values obtained were 1.04, 0.59 and 1.65 respectively, whereas 't' values for ITT,PT, S/C and T4R were found to be 6.5, 11.42, 11.04, 2.22 respectively. These 't' values were found significant at 0.05 level of confidence.

Hypothesis 6

The time spent on different categories and behaviour ratios does not differ with the cognitive maturity of teachers at three different levels.

Table 31

Number of tallies and percentage of time spent on 1 to 10 categories

CATEGORIES									
1	2	3	4	5	6	7	8	9	10
13	113	381	2444	3228	123	160	1940	106	3861
(.11)	(.91)	(3.08)	(19.76)	(26.1)	(0.99)	(1.29)	(15.68)	(.86)	(31.22)
122	209	962	6205	4233	502	351	4438	300	8613
(.43)	(.81)	(3.71)	(23.92)	(16.32)	(1.94)	(1.35)	(17.11)	(1.16)	(33.21)
64	136	765	3327	1827	730	156	3145	131	2886
(.48)	(1.03)	(5.81)	(25.26)	(13.87)	(5.54)	(1.18)	(23.88)	(0.99)	(21.92)

The figures outside the bracket shows number of tallies, while the figures inside the brackets show percentage of time.

A close scrutiny of table 31 provides the following results :

1. Percentage of time spent on categories 1, 3, 4, 6 and 8 clearly indicates that 1 increases from concrete to formal to group through transitional group. These categories are 'accept feeling', 'accept ideas', 'ask question', 'give direction', and 'student response' respectively. So we can infer that this increase will be conducive to the comparative effectiveness of the group.

2. The time spent on categories 5 and 10 decreases from concrete to formal through transitional group. Whereas transitional group on category 10 showed slightly increase in percentage from the concrete group, the decreasing property of consuming time on these category (Lecturing and silence or confusion) again shows the relative effectiveness of the group.

3. The time spent on categories 2, 7 and 9 more or less is the same.

The times spent by concrete, transitional and formal operational teachers on different categories are also represented by graphs 5, 6 and 7.

4. The time spent on questioning by teachers of different cognitive maturity level have also been calculated as 4 types of questioning were noted. It is represented in table 32.

Table 32

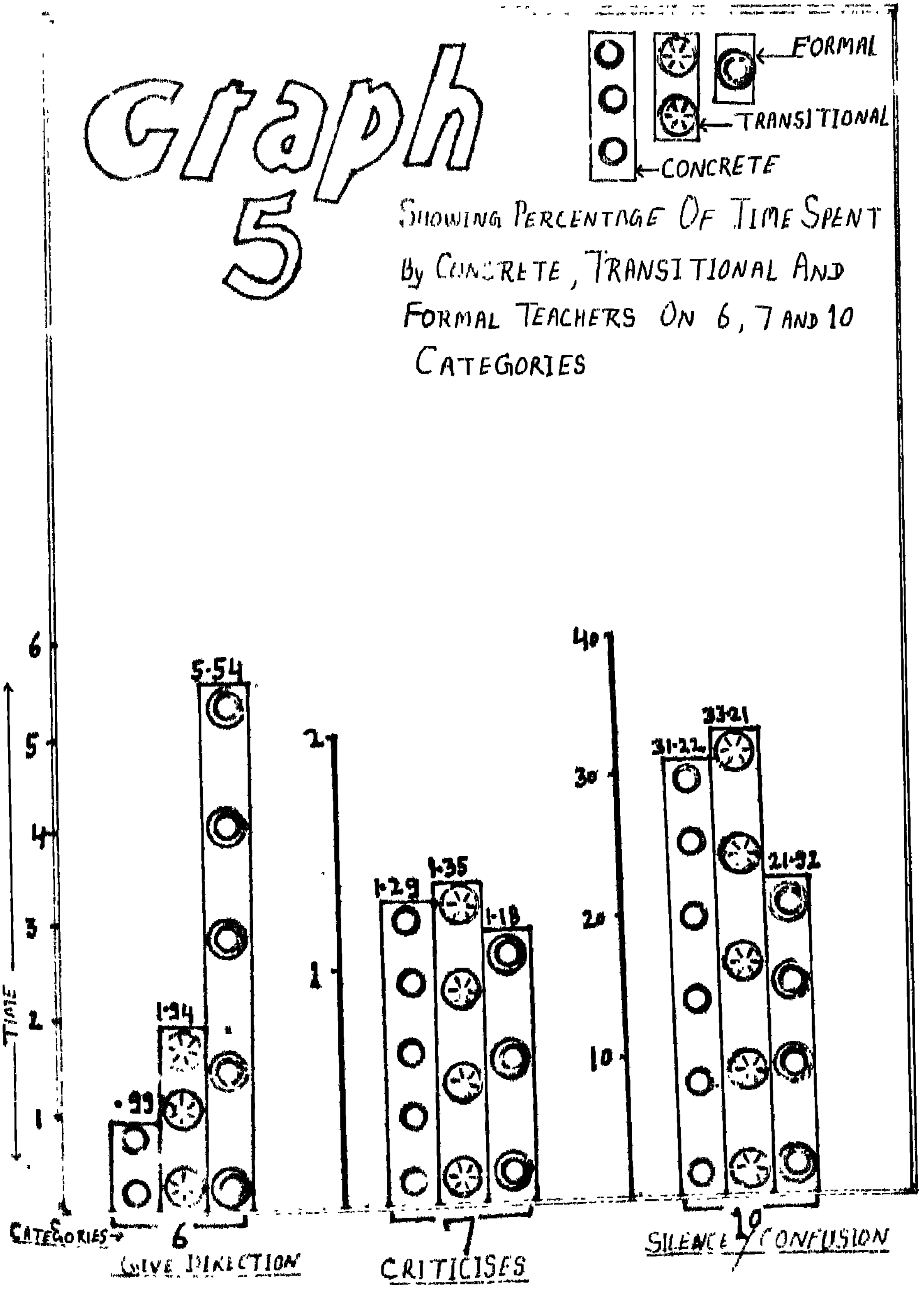
Percentage of time spent on type of questioning

Group	Type of questions			
	Cognitive memory	Convergent	Divergent	Evaluative
Concrete	81.18	1.52	6.91	10.39
Transitional	82.22	1.35	10.91	5.52
Formal	83.46	1.26	4.96	10.30

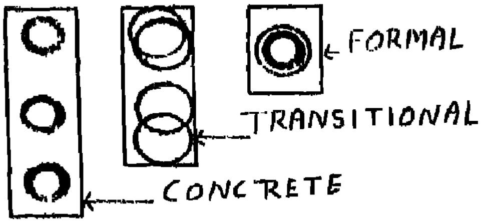
Table 32 indicates that time spent on first two types of questioning namely, cognitive memory and convergent type were more or less same in the

Graph 5

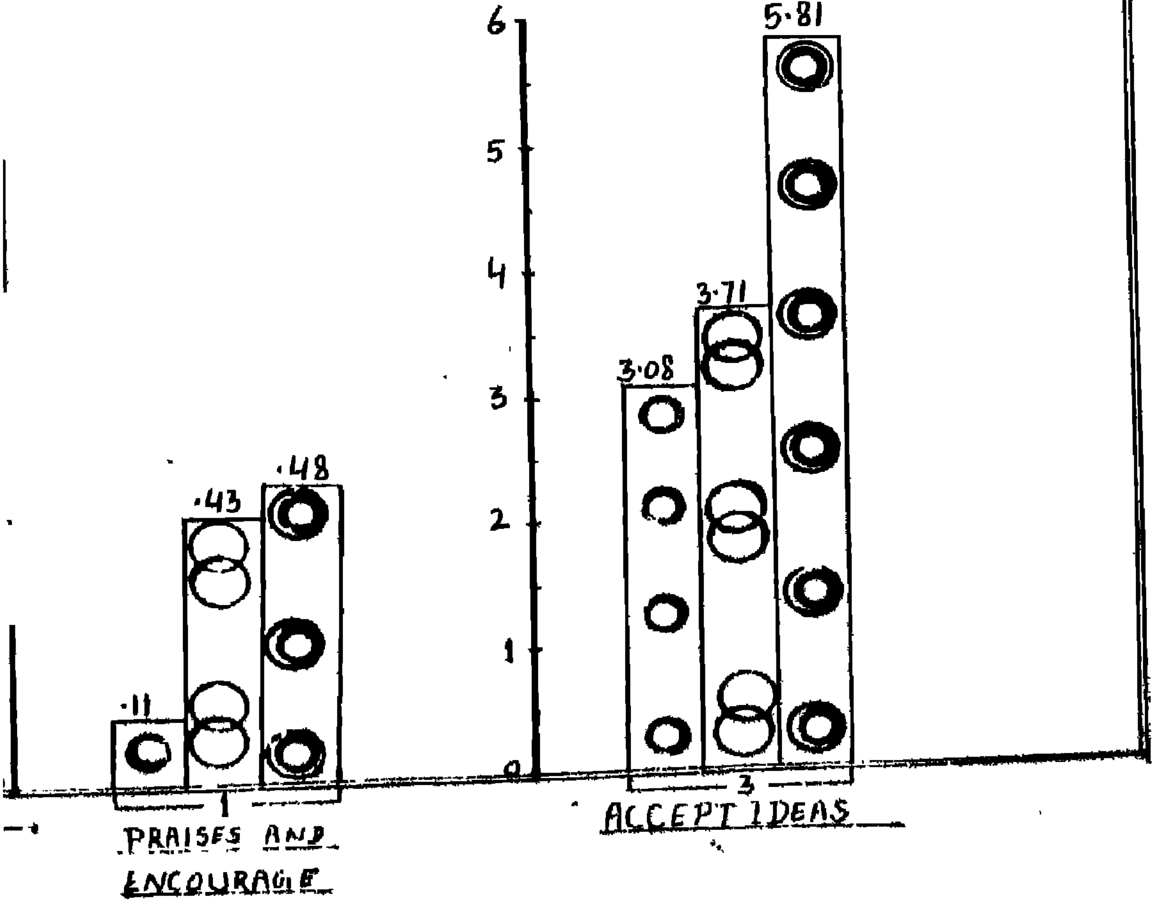
Showing Percentage Of Time Spent By Concrete, Transitional And Formal Teachers On 6, 7 and 10 Categories



RAPH
6

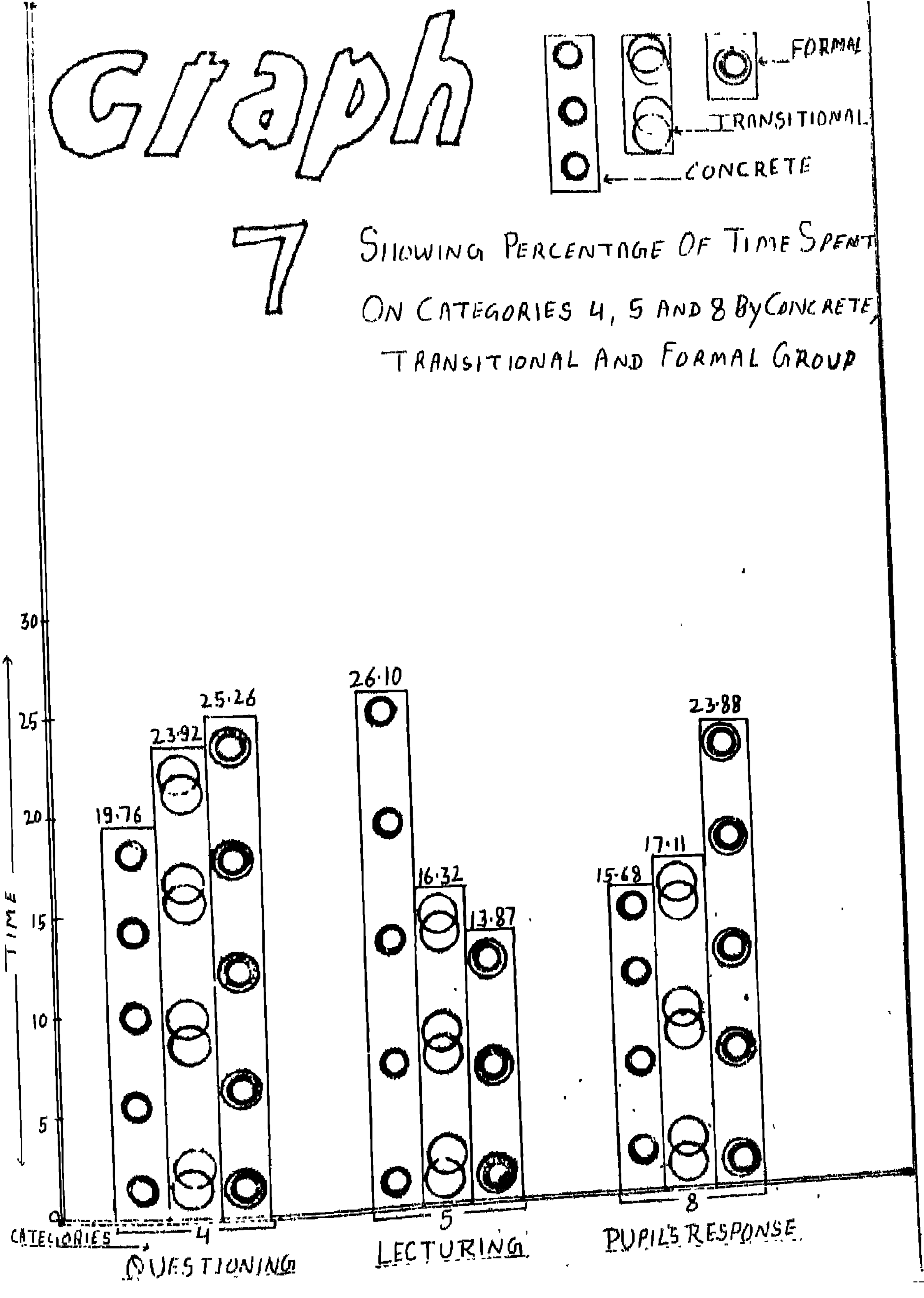


Showing Percentage Of Time Spent On Categories 1 And 3 By Concrete, Transitional And Formal Group



Graph 7

Showing Percentage Of Time Spent On Categories 4, 5 and 8 By Concrete, Transitional and Formal Group



three groups, while times spent on divergent questioning were found to be 6.91, 10.91 and 4.96 by concrete, transitional and formal group respectively. Similarly, times spent on evaluative type question were 10.39, 5.52 and 10.30 percent by concrete, transitional and formal group respectively.

Table 33

Percentage of time spent on steady state cells by concrete, transitional and formal groups

up	C E L L S			
	(4-4)	(5-5)	(8-8)	(9-9)
crete	9.56	22.02	7.15	0.32
nsitional	12.02	13.06	7.32	0.53
mal	12.08	10.70	13.88	0.25

Times spent on (4-4), (5-5), (8-8) and (9-9) steady state cells by concrete, transitional and formal group teachers have been mentioned, in table 33. The table reveals that 9.56%, 12.02%, 12.08% time was spent on 4-4 cell, 7.15%, 7.32% and 13.88% time was spent on (8-8) cell, 22.02%, 13.06% and 10.70% time was spent on (5-5) cell while 00.32%, 0.53% and 0.25% time was spent on 99 cell by concrete, transitional and formal groups respectively. Further table indicates that formal teachers asked more questions and gave opportunities to respond to their pupils. They lectures less than concrete operational teachers.

Table 34

Percentage of time spent on various Interaction Variables by concrete, transitional and formal groups

Interaction variables										
TT	ITT	DTT	PT	S/C	I/D	i/d	PIR	TRR	TQR	CCR
52.24	23.86	28.38	16.54	31.22	1.46	4.74	6.58	59.00	46.87	45.84
48.51	28.91	19.61	18.27	33.21	3.17	2.29	6.43	59.52	62.98	40.28
53.20	32.59	20.60	24.88	21.92	2.27	2.09	4.67	51.67	66.24	38.80

By scrutinising table 34, the following results were obtained :

1. The interaction variable TT, DTT, TRR and CCR shows decreasing values of time spent on the above behaviour ratios by concrete to formal through transitional, which shows the relative effectiveness of the behaviour of the group.

2. The PT shows clear-cut increasing value from concrete to formal group through transitional. It is again conducive to relative effectiveness of the group.

3. The value of I/D, S/C and TQR were more or less similar in concrete and formal groups. The formal teachers were slightly more indirect than the concrete teachers as I/D ratios obtained were 6.90 and 7.31 for concrete and formal groups respectively.

4. The PIR value in the table are 8.85, 5.37 for concrete and formal group, while values for i/d are 5.96 and 5.58 for concrete and transitional groups respectively.

CONCLUSIONS

The main conclusions of hypotheses 1 to 6 are given below :

1. Out of 129 student teachers, 31 were on concrete level, 65 were on transitional level and 33 were on formal level. Their mean and standard deviations were 9.968 (± 1.74), 18.94 (± 2.52), 26.85 (± 1.46) respectively.

2. No significant relationship was found in between cognitive maturity levels and creativity.

3. No significant relationship was found between cognitive maturity levels and scientific attitude.

4. Percentage of time spent on categories, 1, 2, 3, 4, 6 and 8 increased from concrete through transitional to formal, while for categories 5 and 10 it decreases. Both contribute towards the relative effectiveness of the group.

5. Similarly, increasing value of Indirect Teacher Talk (ITT), Pupil Talk (PT), Teacher Question Ratio (TQR) behaviour ratio and decreasing value of teacher Talk (TT), Silence/Confusion (S/C) and Content Cross Ratio (CCR) from Concrete to Transitional and Formal Stage relative effectiveness of the group.

6. The clock-wise flow indicated that the formal group is comparatively more effective than concrete and transitional groups.

7. The Box flow diagrams indicated that formal group used category 2 which is absent in concrete and

transitional groups. Hence, the teaching behaviour of formal group is more effective than that of concrete and transitional groups.

8. Significant difference was observed from Teacher question Ratio (TQR) of formal level teachers in between the following groups :
(A) High and low creative teachers
(B) Average and low creative teachers.

9. Significant difference was observed on Teacher Talk (TT), Direct Teacher Talk (DTT), Teacher Question Ratio (TQR) and Content Cross Ratio (CCR) between average and low scientific attitude teachers at transitional level.

10. Concrete, Transitional and Formal Teachers showed Direct Teacher Talk (DTT), Pupil Talk (PT), Silence/Confusion (S/C), Small indirect to direct ratio (i/d), Teacher Question Ratio (TQR), Content Cross Ratio (CCR) behaviour ratios.

CHAPTER VI

MATHEMATICAL STRUCTURE FOR SCIENCE TEACHERS

INTRODUCTION

In order to test hypothesis VIII, it was decided to factor analyse the correlation matrix (30x30) involving eight variables of cognitive maturity seven variables of scientific attitude, four variables of creativity and eleven interaction variables (See Appendix G). The half of the correlation matrix is shown in the table 35. On going through the table it is seen :

(i) 242 positive correlation coefficient.

(ii) 193 negative correlation coefficient.

(iii) 88 coefficients of correlation are significant at .05 level of confidence.

(iv) 69 coefficient of correlation are significant at .01 level of confidence.

(v) All the coefficients of correlations are between .001 to .692.

The main purpose of factor analysis was to explain the pattern of factors underlying science teaching.

Hypothesis 7

There does not exist mathematical structure in regard to the tests and tools used in the study.

Table 35 shows correlation matrix of 30 x 30 pressage - process variables for 129 subjects, were analysed

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1.	1																													
2.	324**	1																												
3.	115	094	1																											
4.	499**	280**	065	1																										
5.	359**	$\overline{041}$	024	075	1																									
6.	530**	034	$\overline{011}$	040	019	1																								
7.	694**	196*	$\overline{073}$	272**	117	250	1																							
8.	639**	152	020	211*	077	195	144	1																						
9.	001	$\overline{010}$	$\overline{194}$*	$\overline{053}$	029	055	$\overline{080}$	109	1																					
10.	$\overline{023}$	$\overline{100}$	$\overline{066}$	$\overline{025}$	$\overline{148}$	$\overline{009}$	$\overline{106}$	204*	557**	1																				
11.	$\overline{061}$	045	005	$\overline{023}$	003	029	$\overline{030}$	$\overline{133}$	458**	022	1																			
12.	$\overline{006}$	$\overline{038}$	$\overline{156}$	$\overline{152}$	095	025	$\overline{029}$	069	653**	234**	267**	1																		
13.	057	053	$\overline{043}$	035	098	040	$\overline{060}$	113	523**	166	139	176*	1																	
14.	171*	105	$\overline{146}$	007	139	131	101	123	479**	129	$\overline{087}$	177*	274**	1																
15.	$\overline{119}$	$\overline{068}$	$\overline{213}$*	005	$\overline{080}$	$\overline{029}$	$\overline{114}$	$\overline{018}$	588**	171*	296**	277**	121	001	1															
16.	002	135	$\overline{115}$	123	$\overline{012}$	$\overline{092}$	$\overline{075}$	096	092	111	$\overline{090}$	066	$\overline{149}$	$\overline{011}$	272**	1														
17.	030	183*	$\overline{053}$	127	051	$\overline{107}$	$\overline{071}$	101	138	104	006	148	$\overline{156}$	$\overline{008}$	262**	87[illegible]**	1													
18.	056	190*	$\overline{080}$	139	098	$\overline{093}$	$\overline{065}$	116	113	108	$\overline{061}$	102	$\overline{066}$	$\overline{008}$	226**	892**	857**	1												
19.	005	050	$\overline{106}$	066	$\overline{125}$	$\overline{014}$	$\overline{032}$	113	029	076	$\overline{157}$	$\overline{036}$	$\overline{046}$	$\overline{031}$	217*	748**	458**	520**	1											
20.	013	042	065	$\overline{264}$**	$\overline{001}$	009	$\overline{002}$	133	$\overline{120}$	$\overline{001}$	$\overline{113}$	$\overline{128}$	$\overline{028}$	$\overline{004}$	$\overline{117}$	$\overline{083}$	$\overline{068}$	$\overline{017}$	$\overline{036}$	1										
21.	320**	165	018	162	128	081	233**	241**	014	$\overline{119}$	014	$\overline{046}$	121	123	$\overline{002}$	064	013	117	000	311**	1									
22.	$\overline{211}$*	$\overline{077}$	049	$\overline{369}$**	$\overline{089}$	$\overline{046}$	$\overline{164}$	$\overline{041}$	$\overline{128}$	078	$\overline{117}$	$\overline{093}$	$\overline{111}$	$\overline{089}$	$\overline{114}$	$\overline{125}$	$\overline{094}$	$\overline{099}$	$\overline{035}$	745**	$\overline{401}$**	1								
23.	359**	139	070	182*	166	086	262**	210*	$\overline{099}$	$\overline{174}$*	$\overline{066}$	$\overline{015}$	048	045	$\overline{103}$	040	$\overline{008}$	051	028	094	529**	$\overline{281}$**	1							
24.	$\overline{195}$*	$\overline{096}$	$\overline{087}$	109	$\overline{097}$	$\overline{048}$	$\overline{149}$	$\overline{214}$*	150	100	125	115	$\overline{007}$	$\overline{022}$	149	052	080	$\overline{012}$	017	$\overline{844}$**	$\overline{526}$**	$\overline{443}$**	$\overline{607}$**	1						
25.	072	028	009	148	037	$\overline{043}$	131	$\overline{043}$	024	$\overline{111}$	184*	014	007	$\overline{087}$	109	077	078	078	014	$\overline{263}$**	270**	$\overline{514}$**	141	139	1					
26.	$\overline{182}$*	$\overline{023}$	022	$\overline{054}$	029	$\overline{223}$	$\overline{088}$	$\overline{157}$	$\overline{002}$	$\overline{119}$	126	059	$\overline{010}$	$\overline{099}$	074	082	$\overline{021}$	019	063	021	130	$\overline{073}$	$\overline{047}$	011	377**	1				
27.	$\overline{083}$	$\overline{011}$	032	024	$\overline{069}$	015	$\overline{067}$	$\overline{090}$	002	056	102	145*	$\overline{042}$	$\overline{240}$**	$\overline{003}$*	$\overline{120}$	$\overline{076}$	$\overline{057}$	$\overline{082}$	$\overline{082}$	$\overline{461}$**	245**	$\overline{166}$	154	$\overline{146}$	$\overline{168}$	1			
28.	$\overline{071}$	019	088	005	005	$\overline{154}$	006	$\overline{090}$	093	$\overline{078}$	140	$\overline{028}$	136	102	078	$\overline{028}$	$\overline{094}$	$\overline{038}$	$\overline{070}$	$\overline{021}$	232**	$\overline{166}$	016	013	229**	607**	$\overline{291}$**	1		
29.	294**	130	$\overline{086}$	376**	157	065	193*	145	076	$\overline{064}$	053	003	128	061	101	151	106	161	060	$\overline{467}$**	596**	$\overline{869}$**	396**	159	549**	022	$\overline{301}$**	037	1	
30.	$\overline{195}$*	$\overline{055}$	021	$\overline{348}$**	$\overline{020}$	$\overline{058}$	$\overline{161}$	$\overline{048}$	$\overline{115}$	013	$\overline{106}$	$\overline{106}$	$\overline{070}$	$\overline{020}$	$\overline{107}$	$\overline{097}$	$\overline{106}$	$\overline{055}$	$\overline{022}$	866**	$\overline{002}$	836**	$\overline{133}$	$\overline{613}$**	$\overline{313}$**	040	$\overline{014}$	$\overline{032}$	$\overline{547}$**	1

** Significant at .01 level of confidence.

* Significant at .05 level of confidence.

Note: Name of variables are given in Appendix VI

Figures are in 1/1000.

through the process of factor analysis. This technique is a most useful tool where a large number of interrelated measures are to be reduced to a few underlying factors. Ten principal factors were obtained with their eigne value greater than one. Any factor whose eigne value is greater than one is supposed to be significant. These 10 factors carried the cumulative percentage of variation upto 75.8%.

These 10 factors were rotated in accordance with the criterion of Kaiser's (1958) varimax procedure. The rotated factor matrix thus obtained is given in table 36. As no uniform policy was found for the selection of significant factor loading, it was decided by the investigator that, for the purpose of discussing the results of varimax factor matrix, the factor loading .40 or above were considered to be significant. The level was also adopted by Jerry S. Carlson and Karl Heinz Wiedl in a study 'The Factorial Analysis of Perceptual and Abstract Reasoning abilities in tests of Concrete operational thought. The factors having loading magnitude .4 or above are mentioned in table 37.

Recently Prof. R.B. Cattle has suggested a technique called 'Scree test', which still reduces the number of significant factors for meaningful interpretation from a psychological view-point. When this exercise is done, only five factors appeared, which are represented through graph 8.

Table 36

Varimax rotated factor matrix

Variables		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	h^2
1.	Logical operation (Total)	.106	.027	-.070	.217	.826	-.047	.034	.291	.287	.277	[illegible]
2.	Classification operation	-.019	.145	.006	.096	.134	-.012	.114	-.096	.837	-.065	[illegible]
3.	Seriation operation	-.043	-.162	-.230	.019	-.189	.151	-.359	.407	.343	.222	[illegible]
4.	Logical multiplication operation	.303	.117	-.125	.086	.281	[illegible]	-.071	.183	.500	.016	[illegible]
5.	Compensation operation	.036	.020	.024	.118	.122	.033	.102	-.044	-.067	.886	[illegible]
6.	Proportional thinking operation	.002	-.105	.067	.005	.684	[illegible]	.029	.076	-.089	-.057	[illegible]
7.	Probability operation	.077	-.056	-.061	.146	.763	.044	.046	-.166	.172	.051	.681
8.	Correlational thinking	-.037	.137	-.040	.210	.418	-.090	.053	.646	.057	.057	[illegible]
9.	Scientific attitude (Total)	.067	.057	.852	-.056	-.024	.014	.403	.286	-.016	-.022	.957
10.	Rationality	-.029	.108	.314	-.164	-.047	-.109	.150	.645	-.164	-.215	.664
11.	Curiosity	.073	-.155	.703	.007	-.015	.166	-.237	-.150	.184	-.027	.667
12.	Open-mindedness	.039	.064	.710	-.068	.019	-.063	.093	.065	-.132	.255	.614
13.	Aversion to superstitions	.068	-.217	.360	.123	-.167	.011	.430	.316	.184	.057	.546
14.	Objectivity	-.002	-.027	.119	-.005	.115	-.017	.836	.053	.086	.134	.756
15.	Suspend judgement	.087	.292	.633	-.005	-.011	.083	.002	-.012	-.125	-.250	.579
16.	Verbal creativity (Total)	.068	.976	.027	.027	-.045	.032	.005	.016	.026	-.016	.963
17.	Fluency	.063	.890	.123	-.014	-.069	-.051	-.039	-.005	.125	.120	.849
18.	Flexibility	.026	.905	.085	.076	-.072	-.017	-.005	.029	.123	.133	.872
19.	Originality	.007	.741	-.077	-.008	.050	.023	.026	.081	-.078	-.231	.624
20.	Teacher Talk (TT)	-.916	-.021	-.063	-.314	.039	.039	-.002	.056	.005	-.031	.949
21.	Indirect teacher talk (ITT)	.038	.037	.001	.677	.136	.228	.128	.044	.054	-.018	.863
22.	Direct teacher talk (DTT)	-.910	-.046	-.064	-.315	-.056	-.125	-.091	.021	-.034	-.016	.961
23.	Pupil talk (PT)	.051	-.001	-.054	.764	.115	-.128	-.038	-.001	.113	.160	.669
24.	Silence oblique confusion (S/C)	.700	.023	.080	-.607	-.095	.042	.025	-.039	-.063	-.068	.883
25.	Indirect to direct ratio (I/D)	.452	.046	.131	.345	.060	.419	-.218	-.098	-.062	-.043	.610
26.	Small indirect to direct ratio (i/d)	-.021	.052	.073	-.002	-.110	[illegible]	-.111	-.088	-.057	.049	.776
27.	Pupil initiation ratio (PIR)	-.006	-.117	.233	-.411	-.013	-.323	-.489	.008	.153	.088	.616
28.	Teacher response ratio (TRR)	.034	-.082	.025	.035	-.077	.850	.184	.016	.086	-.006	.779
29.	Teacher question ratio (TQR)	.745	.095	.034	.569	.094	.035	.066	.009	.025	.008	.901
30.	Content cross ratio (CCR)	-.924	.026	-.064	.022	-.065	.051	.013	-.029	-.076	-.028	.677

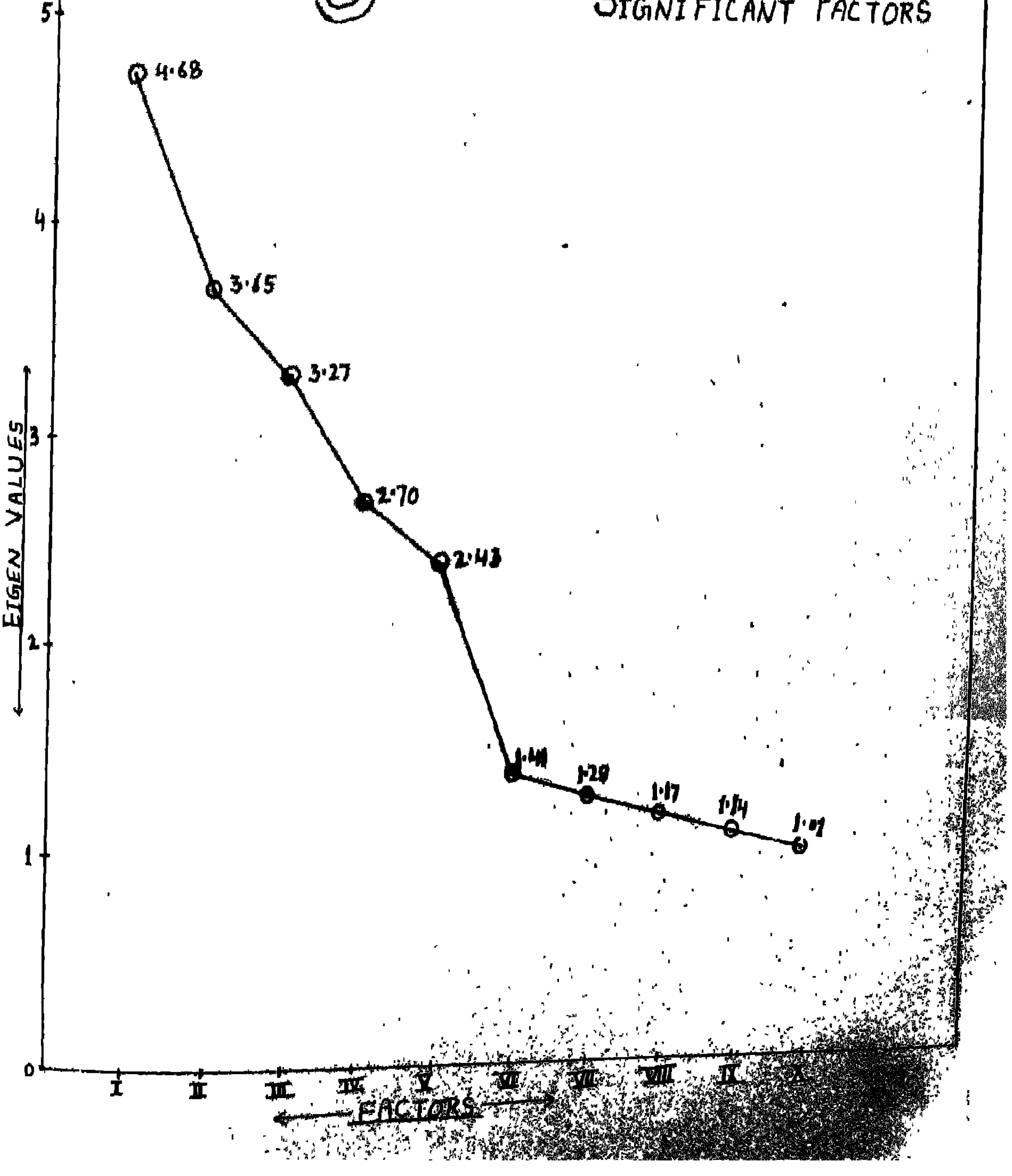
Table 37

Factor loading more than .40

Variable No.		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
1.	Logical operation (Total)					.826					
2.	Classification operation									.837	
3.	Seriation operation								.407		
4.	Logical multiplication operation									.500	
5.	Compensation operation										.880
6.	Proportional thinking operation					.684					
7.	Probability operation					.765					
8.	Correlational thinking					.418			.646		
9.	Scientific attitude (Total)			.852				.403			
10.	Rationality								.645		
11.	Curiosity			.703							
12.	Openmindedness			.710							
13.	Aversion to superstitions							.430			
14.	Objectivity							.836			
15.	Suspended judgement			.633							
16.	Verbal creativity (Total)		.976								
17.	Fluency		.890								
18.	Flexibility		.905								
19.	Originality		.741								
20.	Teacher Talk (TT)	-.916									
21.	Indirect teacher talk (ITT)				.877						
22.	Direct teacher talk (DTT)	-.910									
23.	Pupil talk (PT)				.784						
24.	Silence oblique confusion (S/C)	.700			-.667						
25.	Indirect to direct ratio (I/D)	.452					.450				
26.	Small indirect to direct ratio (i/d)						.854				
27.	Pupil initiation ratio (PIR)				-.411			-.490			
28.	Teacher response ratio (TRR)						.850				
29.	Teacher question ratio (TQR)	.743			.569						
30.	Content cross ratio (CCR)	-.924									

GRAPH 8

Showing Eigen Values Of Significant Factors



INTERPRETATION OF FACTORS

The Varimax Factor I

With an eigen value of 4.68 the factor has got significant factor loading, more than .40 on following variables :

Table 38

Factor Loading on Varimax Factor I for Science Teachers

S.No.	Variable	Loading
1.	Teacher question ratio	0.743
2.	Silence or confusion	0.700
3.	Indirect to direct ratio	0.452
4.	Content Cross ratio	- 0.924
5.	Teacher - Talk	- 0.916
6.	Direct Teacher Talk	- 0.910

This factor is, therefore, interpreted as 'supplying information'.

The Varimax Factor II

With an eigen value of 3.65 the factor loads on the following variables :

Contd.

Table 39

Factor Loading on Varimax Factor II for Science Teachers

S.No.	Variable	Loading
1.	Verbal Creativity	0.976
2.	Flexibility	0.905
3.	Fluency	0.890
4.	Originality	0.741

In view of the above data, this factor may be named as 'Creativity'.

The Varimax Factor III

With an eigen value of 3.27 the factor has got loading on the following variables :

Table 40

Factor Loading on Varimax Factor III for Science Teachers

S.No.	Variable	Loading
1.	Scientific attitude	0.852
2.	Open-mindedness	0.710
3.	Curiosity	0.703
4.	Suspended Judgement	0.633

Therefore, this factor is named as 'Scientific attitude'.

The Varimax Factor IV

With an eigen 2.70 the factor showed loading on the following variables :

Table 41

Factor Loading on Varimax Factor IV for Science Teachers

S.No.	Variable	Loading
1.	Indirect Teacher talk	0.877
2.	Pupil Talk	0.784
3.	Teacher Question ratio	0.569
4.	Silence or Confusion	- 0.667
5.	Pupil initiation ratio	- 0.411

In view of the above facts, this factor appears to be very complex in nature. However, it may be named as 'Reinforcing pupil activity'.

The Varimax Factor V

With an eigen value 2.70 this factor has got loading on the following variables :

Contd.

Table 42

Factor Loading on Varimax Factor V for Science Teachers

S.No.	Variable	Loading
1.	Logical Operation (total)	0.826
2.	Probability Operation	0.763
3.	Proportional Thinking Operation	0.684
4.	Correlational Thinking	0.418

This factor is interpreted as 'Cognitive maturity'.

Comparison with other studies

No study of this type has come into the notice of the investigator. However, it is of interest to mention a study on "Emerging Pattern of Teacher Behaviour", by Brij Kishore Sharma. He developed a Science Teacher Behaviour Inventory in which there were 20 categories which are given below :

1. Teacher utilises students' response/accepts ideas/ praises.
2. Teacher handles/builds students' response.
3. Teacher summarises/writes on black board.
4. Teacher poses questions.
5. Teacher gives lecture : facts, concepts, notes.
6. Student- student interaction.
7. Student initiates/asks questions.
8. Student gives response.

9. Teacher uses resource material/charts/maps/diagrams.

10. Teacher shows models/demonstrates/experiments.

11. Teacher provoked to anger/criticizes/penalizes reprimands.

12. Teacher gives direction/commands/moralizes/controls students.

13. Teacher admits fault/personal ignorance/postpones.

14. Teacher supervises.

15. Teacher pauses

16. Teacher provides opportunity to students to think.

17. Students copying notes/diagrams etc.

18. Students experimenting (Individual/groups).

19. Interruption by external agency.

20. when no meaningful activity is going on.

Using the centroid method, six factors were extracted. The emerged picture is reproduced below :

Factor	S.No.	Items	Nomenclatures
I	1.	Teacher gives lectures, facts, concepts, notes	giving or supplying information
	2.	Student experimenting	
	3.	Teacher gives direction/ commands/moralizes/controls students	
	4.	Teacher poses questions	
II	1.	Student gives response	Getting Feedback from students
	2.	Teacher admits fault/personal ignorance/postpones	
	3.	Teacher gives direction/ commands/moralizies/controls	
	4.	Teacher handles/builds student response	
	5.	Teacher supervises	

Factor	S.No.	Items	Nomenclatures
III	1.	Teacher uses resource material/charts/maps/diagrams.	Using illustration material
	2.	Teacher admits fault/personal ignorance/postpones.	
	3.	Teacher supervises	
IV	1.	Students experimenting (individual/group)	Practical factor
V	1.	Teacher summarizes/writes on blackboard	Summarizing (oral/written) factor
	2.	Teacher supervises	
	3.	Students initiated/asks questions	
	1.	Teacher handles/builds students' response	Handling and building pupils response
	2.	Teacher pauses	

On comparing the results, only one factor appeared which is common between his study and the present study. The factor is, supplying information. Other factors were different because the present study included other variables which were not considered at all by Brij Kishore Sharma.

Conclusion.

Interpretations made in the study regarding the mathematical structure of science teacher behaviour investigated through Amidon and Hunter Verbal Interaction Category system are tentative. In fact, a large study is needed which includes several measurable aspects of science teachers. When such results become available, these need to be further checked against hard facts of the field.

It cannot be said with certainty aboout the emergence and relevance of these factors because factors are 'hypothetical mental constructs', 'blurred averages' and 'products of thinking' which are unstable by their very nature. They depend upon nature of the tests used, population tested and point of view held by the investigator. It is difficult even to name them merely on the basis of their external characteristics, features and mode of appearance, without considering the mental operations involved or process of thinking carried over. It will be of interest to mention here that the external forms of the factors and their underlying contents are hardly considered at the same time. Thus it is only for the qualitative studies done under controlled conditions that new and farsighted hypotheses may appear for large-scale testing. Lastly, the field of science education is just emerging in our country and the present study is a small attempt in that direction.

CHAPTER VII

SUMMARY

THE PROBLEM

The present plan is designed to study the cognitive maturity (concrete, transitional and formal) of prospective science teachers and their relationship with classroom verbal behaviour, verbal creativity and scientific attitude. The title of the present investigation is therefore -

"A STUDY OF PIAGETIAN COGNITIVE DEVELOPMENT
AND ITS RELATIONSHIP WITH TEACHING EFFECTIVENESS
OF PROSPECTIVE SCIENCE TEACHERS".

PAST WORK

The published and unpublished literature in the area of teacher's cognitive development and teacher behaviour (Presage-Process area) was studied to avoid the duplication of the findings. It was seen that some researches have been done at Ph.D. and M.Ed. levels to relate different presage variables (aptitude, attitude, interest, intelligence, creativity, personality, self-concept, academic grade and adjustment) with process variables (classroom verbal behaviour pattern, classroom rating, teaching skills, etc.)

Quraishi (1972); Sharma A.M. (1972); Patel (1974); Singh (1974); Pachauri A. (1974); Vijendra (1972); Sharma [illegible] (1975); Bhargava (1976); Mathew George (1976); Baranwal (1978); Goel S. (1978); Saran (1979); Jadaun (1982) have conducted studies to relate different presage variables with process variables - the classroom verbal behaviour of

teachers.

On the other hand, Elkind (1962); Towler and Wheatly (1971); Lawson et al (1975); Rauchaury (1973); Das Gupta (1977); Lovell (1971); Chase and Collinson (1962) and Randall (1967) reveal that a majority of pre-service secondary science teachers functioned at transitional stage i.e. in between concrete and formal operational stage.

Similarly, several researches have been conducted on teaching effectiveness. Studies of Filson (1957); Lashier (1965); Johns (1966); Morrison (1966); Soar (1966); Furst (1967); Weber (1968); Pankratz (1967); Penney (1969); Lulla (1973); Flander (1970); Pareek and Rao (1971); Kavanasam (1977); state that significant positive relationship exists between indirect teacher behaviour and achievement. So it is assumed by investigator that indirect teaching behaviours are more effective than direct teaching behaviour.

HOW PRESENT STUDY DIFFERS FROM OTHER STUDIES

This study differs from other studies in the following ways :

1. Cognitive maturity of science teachers was measured.
2. Cognitive development, verbal creativity and scientific attitude were considered as presage variables.
3. Relationship among cognitive maturity, scientific attitude and verbal creativity were computed and

interpreted.

4. The teacher classroom behaviour (Process variable) was coded by VICS (Amidon and Hunter, 1966).

5. Relative effectiveness of concrete, transitional and formal teachers was judged by calculating 11 behaviour ratios.

6. Verbal behaviour pattern for concrete, transitional and formal teachers was measured separately.

7. Attempt was made to know the mathematical structure of science teaching.

OBJECTIVES

The present study aimed at integrating the following:

(i) To ascertain the level of cognitive maturity, scientific attitude and verbal creativity of prospective science teachers.

(ii) To study the difference in patterns of teaching behaviour at three levels of cognitive maturity.

(iii) To study the various behaviour ratio of different scientific attitude teachers at three levels of cognitive maturity.

(iv) To study the important behaviour ratio of different verbal creativity teachers at three levels of cognitive maturity.

(v) To study the mathematical structure of prospective science teachers.

(vi) To point out the main educational implications regarding teaching patterns and methods of effective teaching based on the findings.

HYPOTHESES

The following null hypotheses were formulated for the present study :

1. High-average and low creative and scientific attitude teachers do not differ in the level of their cognitive development.

2. No significant difference exists in the pattern of teaching behaviour of pupil teachers at three different levels of their cognitive maturity.

3. No significant differences exist in -

   (A) High-average and low creative teachers at concrete / Transitional / and Formal level.

   (b) High / Average / and low creative teachers at Concrete - Transitional - and Formal level with respect to 11 behaviour ratios.

4. No significant differences exist in -

   (A) High - Average - and Low scientific attitude teachers at Concrete / Transitional / and Formal level.

   (b) High / Average / and Low scientific attitude teachers at concrete - Transitional- and Formal level with respect to 11 behaviour ratios (Teacher Talk (TT); Indirect Teacher Talk (ITT); Direct Teacher Talk (DTT); Pupil Talk (PT); Silence/Confusion (S/C); Indirect to Direct Ratio (I/D); Small Indirect to Direct Ratio (i/d); Pupil Initiation Ratio (PIR); Teacher Response Ratio (TRR); Teacher Question Ratio (TQR); Content Cross Ratio (CCR).

5. No significant difference exist among concrete, transitional and formal level teachers with respect to various behaviour ratios (Teacher Talk (TT); Indirect Teacher Talk (ITT); Direct Teacher Talk (DTT); Pupil Talk (PT); Silence / Confusion (S/C); Indirect to Direct Ratio (I/D); Small Indirect to Direct Ratio (i/d); Pupil Initiation Ratio (PIR); Teacher Response Ratio (TRR); Teacher Question Ratio (TQR); Content Cross Ratio (CCR).

6. Time spent on different categories of VICS (Amidon and Hunter, 1966) does not differ with the cognitive maturity of teachers at three different level.

7. There does not exist mathematical structure in regard to the tests and tools used in the study.

PROCEDURE

The study has been conducted, using normative testing survey method and the cross-sectional approach. It was focused to ascertain the relative teaching effectiveness of teachers at three different levels of cognitive maturity with respect to scientific attitude and verbal creativity by using VICS (Amidon and Hunter, 1966).

SAMPLING

The sample for the present study was drawn from the following Colleges of Education after seeking their willingness.

Table 43

Number of Prospective Teachers Representing College and Sex Variables

S.No.	Name of College	Male Cases	Male %	Female Cases	Female %	Total Cases	Total %
1.	Bihani College of Education, Sriganganagar(Raj.)	29	50.88	36	50.00	65	50.39
2.	Dadhimathi College of Education, Sriganganagar	17	29.82	21	29.17	38	29.46
3.	Govt. T.T.College, Bikaner	11	19.30	15	20.83	26	20.15
	Total	57	100.00	72	100.0	129	100.0

Out of 129 student teachers 39 were post graduates while rest 90 were graduates.

METHODOLOGY AND INSTRUMENTATION

Within the context of the above-mentioned sample, Raven's test of Piagets logical operation (1973) was administered on the subjects (N = 129). The collected response sheets were scored out to categorize the student teachers under three different levels of cognitive maturity. The three levels are :

1. Concrete
2. Transitional, and
3. Formal.

Meanwhile the other tests were also given and scored out to categorise the subjects in three categories mentioned below :

1. High
2. Average
3. Low

The tests were :

1. Scientific Attitude Scale, constructed by Dr. Victor Y. Billah and George, A. Zakharisder(1975).

2. Verbal Test of Creative Thinking constructed by Dr. Baqer Mehdi (1973).

During internship programme the classroom verbal behaviours of student-teachers were encoded by using Amidon and Hunter (1960) VICS. The observations were displayed on matrix table. Master matrices were prepared for different groups and different behaviour ratios were calculated.

STATISTICAL ANALYSIS

The following statistical measures were used to analyse the data :

1. Mean
2. Standard deviation
3. Contingency coefficient and chi square
4. Analysis of Variance (F)
5. Significant difference between the means (t)
6. Scott's formula for estimating intra and inter observer reliability for encoding teacher classroom behaviour.
7. Factor analysis.

MAIN FINDINGS

The main findings of the study indicated :

1. Out of 129 student teachers, 31 were on concrete level, 65 were on transitional level and 33 on formal level. Their means and standard deviations are 9.968 (± 1.74), 18.94 (± 2.52), 26.85 (± 1.46) respectively.

2. No significant relationship was found in between cognitive maturity and creativity / scientific attitude.

3. Percent of time spent on categories 1, 2, 3, 4, 6 and 8 increases from concrete through transitional to formal, while for categories 5 and 10 it decreases. Both contribute towards relative effectiveness of the group.

4. Similarly increasing value of Indirect Teacher Talk (ITT), Pupil Talk (PT), Teacher Question Ratio (TQR) behaviour ratio and decreasing value of Teacher Talk (TT), Silence/Confusion (S/C) and Content Cross Ratio (CCR) from concrete to transitional to formal stage further contribute towards relative effectiveness of the group.

5. The teaching behaviour pattern of formal group teachers was found comparatively more effective than concrete and transitional level teachers. The pattern can be named as narrow questions with feed-back.

6. The significant difference was observed for Teacher Question Ratio (TQR) of formal level teachers in between the following two groups :

(A) High and low creative teachers
(B) Average and low creative teachers.

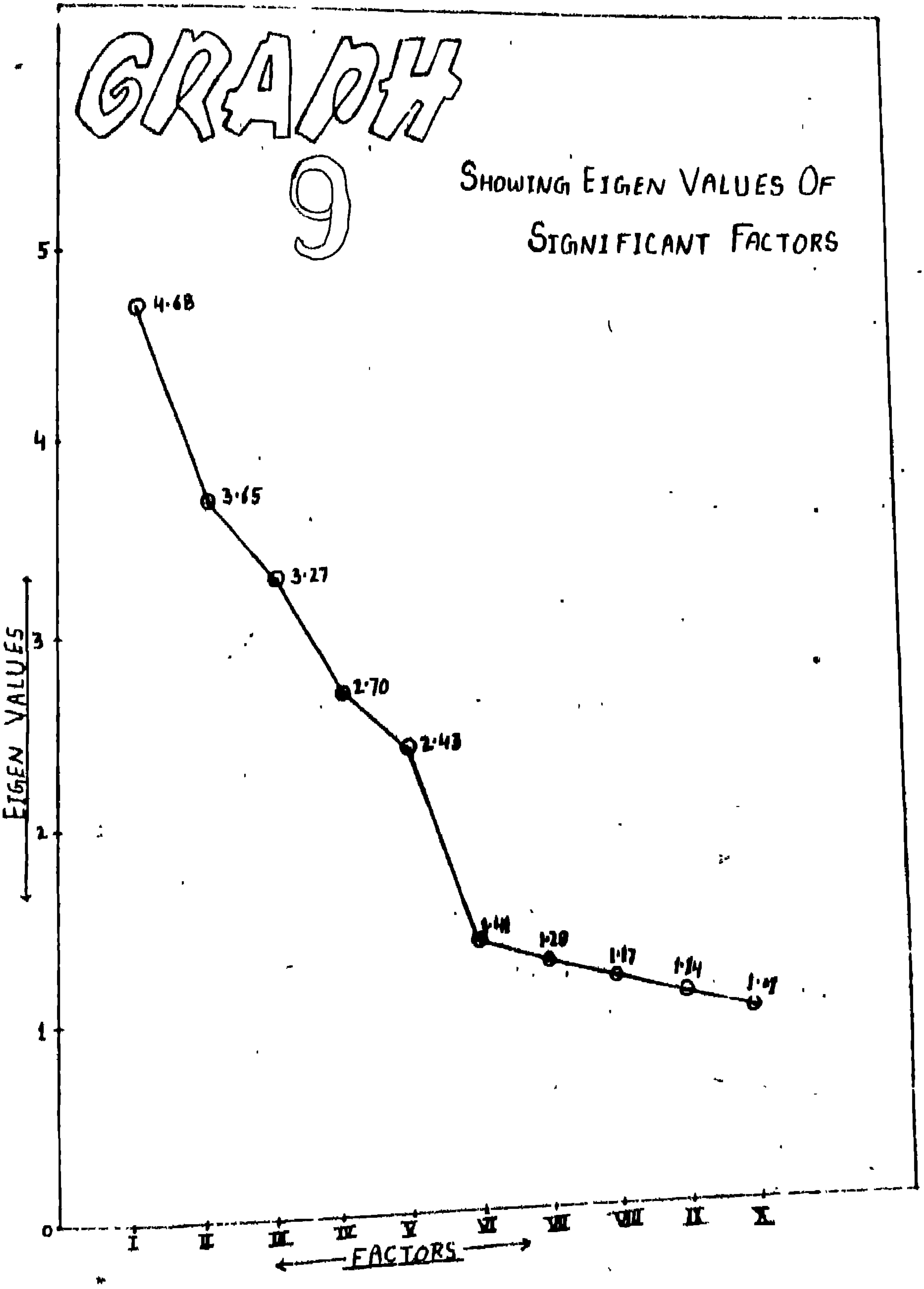
Significant difference was observed on Teacher Talk (TT), Direct Teacher Talk (DTT), Teacher Question Ratio (TQR) and Content Cross Ratio (CCR) in between average and low scientific attitude teachers at transitional level.

Concrete, transitional and formal teachers show significant difference on Indirect Teacher Talk (ITT), Direct Teacher Talk (DTT), Pupil Talk (PT), Silence/Confusion (S/C), Small indirect to direct ratio (i/d), Teacher Question Ratio (TQR), Content Cross Ratio (CCR) behaviour ratios.

The data on 33 variables were subjected to factor analysis using principal components method. 30 factors appeared, out of which 10 factors had their eigne value greater than one. Any factor whose eigne value is greater than one is supposed to be significant. These 10 factors carried the cumulative percentage of variation upto 75.8%.

Recently Prof. R.B. Cattel has suggested a technique lled 'scree' test, which still simplifies or reduces the mber of significant factors, as mentioned above, for eaningful interpretation from psychological view point. hen this exercise was done, it was seen that the following actors appeared :

1. Supplying information
2. Creativity
3. Scientific attitude



GRAPH 9

SHOWING EIGEN VALUES OF SIGNIFICANT FACTORS

4. Reinforcing pupil activity
5. Cognitive maturity.

EDUCATIONAL IMPLICATIONS OF THE STUDY

The present presage-process investigation will have the following educational implication to improve teacher education programme :

1. Finding suggests that formal operational students were more effective in teaching. Hence, Admissions to training colleges can be improved by knowing the cognitive maturity of candidates.

2. The finding suggests that different type of training programme are required for pupils having different level of cognitive maturity.

3. Some sort of special training should be provided to low cognitive maturity pupils.

4. Finding suggest that scientific attitude which contributes towards effective science teaching should be encouraged in training colleges. Similarly, creativity should be fostered among pupil teachers.

5. Findings suggests that effective teachers can be selected for their promotions on the basis of their cognitive maturity. They can be posted at a place where their services are greatly needed.

SUGGESTIONS FOR FURTHER RESEARCH

While reviewing the result of the present study, the investigator realized that there can be a number of research studies which can be undertaken in the presage-

process area. Some suggestions for further research have, therefore, been mentioned in the following lines :

- An investigation of similar type may be designed to evaluate the teaching effectiveness of teachers on the achievement of their pupils (Presage-process-product study)

- Piagetian type tasks or some other tests may be used to measure the cognitive maturity of teachers, in relation to teaching behaviour, to verify the result of the present study.

- A follow-up study may be designed to know the post-training effects of VICS in three different cognitive maturity groups.

- Relationship between cognitive maturity and other presage variables like, personality and self-concept can be judged by designing the study on this line.

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APPENDIX A

RAVENS TEST OF PIAGET'S LOGICAL OPERATION

प्रिय मित्रो,

इस प्रश्नपत्र में कुछ समस्यामूलक प्रश्न दिये गये हैं । प्रत्येक प्रश्न के चार–चार संभावित उत्तर भी नीचे लिखे हैं । आपको प्रत्येक प्रश्न का सही–सही उत्तर ढूंढकर उसका क्रमांक सामने दिये खाने में लिखना है । आपके द्वारा दिये गये उत्तरों को गोपनीय रखा जायेगा । अतः उत्तर पूर्ण निर्भिकता व ईमानदारी से देने हैं । इसके लिए आपको ४५ मिनिट का समय दिया गया है ।

धन्यवाद

इन्हें भरें—

Name—

Name of College

Qualification—

Experience of Teaching (if any)

की धड़कन बढ़ जाती है। जब लिंक्स की संख्या कम होती है उसके दिल की धड़कन बढ़ जाती है। जब लिंक्स की संख्या बढ़ जाती है उसके दिल की धड़कन कम हो जाती है। लिंक्स के दिल की धड़कन का क्षेत्र 'अ' और 'ब' में समान रहेगी।

यदि क्षेत्र 'अ' में खरगोश कम हो जाये तब क्षेत्र 'अ' और 'ब' में लिंक्स के दिल की धड़कन समान रखने के लिए क्या स्थिति होगी—

अ क्षेत्र 'ब' में लिंक्स अधिक हो ब क्षेत्र 'ब' में खरगोश अधिक हो
स क्षेत्र 'ब' में लिंक्स कम हो द क्षेत्र 'अ' में लिंक्स अधिक हो ( )

यदि क्षेत्र 'ब' में लिंक्स अधिक हो जाये तो क्षेत्र 'अ' और 'ब' में लिंक्स के दिल की धड़कन समान रखने के लिए क्या स्थिति होगी—

अ क्षेत्र 'अ' मे खरगोश अधिक हो ब क्षेत्र 'अ' मे खरगोश कम हो
स क्षेत्र 'ब' मे खरगोश अधिक हो द क्षेत्र 'अ' मे लिंक्स कम हो ( )

एक कार 80 मील तीन घन्टे में तय करती है। एक ट्रक 60 मील दो घन्टे में तय करता है। एक नाव 40 मील एक घन्टे मे तय करती है।

सही विवरण चुनो—

अ ट्रक नाव से तेज चलता है। ब कार नाव से तेज चलती है।
स ट्रक कार से तेज चलता है। द ट्रक और कार समान गति से चलते है। ( )

सही विवरण चुनो—

अ नाव कार से धीमे चलती है। ब ट्रक नाव से धीमे चलती है।
स ट्रक कार से धीमे चलता है। द नाव और कार समान गति से चलते है। ( )

एक प्रकार का कीट जो बिर्च पौधों को खा डालता है। इसने पाइन के जंगल, मेपिल के जंगल, एल्प के जंगल तथा एस्पेन के जंगलो पर आक्रमण करना शुरु कर दिया है। पाइन के जंगल में, प्रत्येक 10 पाइन वृक्षों में 2 बिर्च के वृक्ष है। मेपिल के जंगल में प्रत्येक 4 मेपिल वृक्षो मे 3 बिर्च के वृक्ष है। एल्प के जंगल मे प्रत्येक 4 एल्प वृक्षो मे 2 बिर्च के वृक्ष है। एस्पेन के जंगल मे प्रत्येक 10 एस्पेन वृक्षो मे 4 बिर्च के वृक्ष हैं

सम्भवत: किस जंगल मे अधिकतम वृक्ष मिलगे यदि वह कीट नष्ट हो जाये—

अ एल्प ब मेपिल स पाइन द एस्पेन ( )

सम्भवत: किस जंगल मे न्यूनतम वृक्ष मिलेंगे यदि वह कीट नष्ट हो जाये—

अ पाइन ब एस्पेन स एल्प द मेपिल ( )

एक सर्वेक्षण से पता चलता है कि कुछ जानवर किन्ही विशेष वृक्षो पर पाये गये। तीन उल्लू फ़र वृक्षो पर पाये गये। 7 रीछ फ़र वृक्षो के आस-पास पाये गये। 3 रीछ मेपिल वृक्षो के आस-पास पाये गये।

निम्नांकित मे सर्वोत्तम विवरण का चयन कीजिये जो नियम की पूर्ति करता है। जैसा ऊपर कहा गया है-

उल्लू फर वृक्षो पर तथा रीछ वृक्षो के आसपास पाये जाते हैं।

रीछ मेपिल वृक्षो के आसपास तथा उल्लू मेपिल वृक्षो पर पाये जाते हैं।
रीछ मेपिल वृक्षो के आसपास तथा उल्लू फर वृक्षो पर पाये जाते हैं।
रीछ फर वृक्षो के आसपास तथा उल्लू मेपिल वृक्षो पर पाये जाते हैं। ( )

निम्नांकित मे से सर्वोत्तम विवरण का चयन कीजिए जो सम्बन्ध के नियम का अन्त: विरोध प्रदर्शित करे—

उल्लू फर वृक्षो के आसपास तथा रीछ फर वृक्षो के आसपास पाये जाते हैं।
रीछ मेपिल वृक्षो के आसपास तथा उल्लू मेपिल वृक्षो के आसपास पाये जाये है।
रीछ मेपिल वृक्षो के आसपास तथा उल्लू फर वृक्षो पर पाये जाते हैं।
रीछ फर वृक्षो के आसपास तथा उल्लू मेपिल वृक्षो पर पाये जाते हैं। ( )

APPENDIX B

Scoring key for Raven's test of Piaget's Logical Operation

Q.No.	Marks	Right response
*1	1	D
2	1	A
3	1	C
4	1	D
5	2	D
6	2	A
7	2	A
8	2	B
9	3	C
10	3	B
11	3	B
12	3	A
13	4	A
14	4	D

APPENDIX C

गोपनीय

सृजनात्मक चिन्तन-शब्दों द्वारा
(Thinking Creatively with Words)

डॉ० बाकर महदी
एम. ए. (कोलम्बिया), पी.-एच. डी. (अलीगढ़)
प्रोफेसर आफ एजूकेशन,
एन. सी. ई. आर. टी., नई देहली-१६

नाम...जन्म तिथि ... .आयु..

कक्षा.............................अनुभाग.......................विद्यालय ....

पिता या अभिभावक का नाम..व्यवसाय...

घर का पता..दिनाङ्क..

निर्देश

(१) जीवन में नवीनता, मौलिकता एवं रचनात्मक योग्यता का बड़ा महत्त्व है। जीवन की प्रत्येक नई खोज मनुष्य के नये ढंग से सोचने की योग्यता का परिणाम है। संसार की बहुत सी ऐसी वस्तुएँ है जिन्हें नये-नये विचारों के द्वारा अनोखी तथा उपयोगी बनाया जा सकता है। ऐसी योग्यता रखने वाले व्यक्तियों ने ही नयी-नयी खोजें एवं आविष्कार किये हैं।

(२) आगे के पृष्ठों पर कुछ ऐसी समस्याएँ दी गयी हैं जिन्हें यदि आप विचारात्मक एवं सृजनात्मक ढंग से हल करने का प्रयत्न करेंगे तो आप बहुत से नवीन तथा रोचक उत्तर देने में सफल हो सकेंगे। आपको इन कार्यों के करने मे बहुत आनन्द आयेगा।

(३) ये कार्य दिन प्रतिदिन की समस्याओं से सम्बन्धित है। इनका कोई सही या गलत उत्तर नहीं है। देखना यह है कि आप कहाँ तक ऐसी नई एवं अनोखी बातें सोचते हैं जो आपके विचार में आपके साथी नहीं सोच सकते। वास्तव मे विचित्र एवं नवीन उत्तर देने से ही यह पता लग सकेगा कि आप में वस्तुओं को नये ढंग से सोचने की कितनी योग्यता है। अतः जितने भी अधिक नये एवं रोचक विचार आयें, लिखते जाइए चाहे वे असम्भव ही क्यों न मालूम होते हों।

(४) इस पत्रिका में आपको चार प्रकार के कार्य करने के लिए दिये गये हैं। सुविधा के लिए प्रत्येक कार्य का अलग-अलग समय निश्चित है। जहाँ तक सम्भव हो शीघ्रता से उत्तर दीजिए। यदि आप किसी कार्य को निश्चित समय से पहले पूरा कर लेते है तो जब तक आपसे अगले कार्य के लिए न कहा जाये, आगे न बढ़ें बल्कि उसी कार्य के बारे मे शांतिपूर्वक सोचते रहें और जो भी नया विचार आपके मन में आये उसे भी लिख दें। अन्त में पाँच मिनट का समय और दिया जाएगा। यदि आपके मन में किसी भी प्रश्न के किसी भाग के बारे में कोई नवीन विचार आया है जिसे आप पहले नहीं लिख पाये थे, तो उसे इस समय लिख सकते हैं।

(५) प्रत्येक कार्य के हर भाग का उत्तर अवश्य दीजिए। जब आपसे कार्य आरम्भ करने को कहा जाय तो तुरन्त शुरू कर दीजिए।

यदि आपको कोई बात पूछनी है तो इस समय पूछ लीजिए। यदि इस समय कोई कठिनाई नहीं है और बाद में कोई कठिनाई आये तो शांतिपूर्वक अपने स्थान से हाथ उठायें ताकि आपकी कठिनाई दूर की जा सके।

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कार्य (1)

यदि ऐसा हो जाय तो--

निर्देश :—

(१) इस कार्य में नीचे तीन असम्भव बातें दी गई हैं जो कि कभी सत्य नहीं हो सकती। आप केवल यह मान लें कि ऐसा हो गया है। तब आप सोचें कि ऐसा हो जाने पर क्या परिणाम हो सकते हैं।

(२) प्रश्नो का उत्तर देते समय अपने ध्यान और सोचने की शक्ति का पूर्ण तरह प्रयोग करने का प्रयत्न कीजिए और १५ मिनट में आप जितने उत्तर दे सकते है, दीजिए। ऐसे उत्तर देने का प्रयत्न कीजिए जो आपके विचार में आपके किसी साथी ने न सोचे हों।

(३) उत्तर छोटे-छोटे वाक्यों में देने का प्रयत्न कीजिए ताकि दिए हुए समय में अधिक से अधिक लिख सकें।

(४) याद रखिये आपको १५ मिनट में इस कार्य की तीनों समस्याओं के विषय में लिखना है। जब पहले प्रश्न के विषय में कोई उत्तर समझ में न आए तो आप तुरन्त दूसरे प्रश्न को हल करना शुरू कर दीजिए। अगर बीच में या बाद में पहले प्रश्न के विषय में कोई नया उत्तर ध्यान में आए तो उसे भी पहले उत्तरों के साथ लिख दीजिए। आप की सुविधा के लिए हर ५ मिनट समाप्त होने पर आपको बता दिया जायगा।

(५) जब आप से काम आरम्भ करने को कहा जाय तो तुरन्त शुरू कर दीजिए।

नीचे एक उदाहरण दिया जा रहा है जिससे स्पष्ट हो जायगा कि आपको क्या करना है।

प्रश्न—यदि पशु-पक्षी भी मनुष्य के समान बोलने लगें तो क्या होगा ?

उत्तर—१—यह संसार एक विभिन्न प्रकार का संसार दिखाई देगा।
२—पशुओं के राज्य में बहुत से नेता उत्पन्न होंगे।
३—सम्भव है कि एक गधा हमारा नेता हो जाय।
४—यह भी सम्भव है कि वह हमारा प्रधानमन्त्री बन जाय।
५—मनुष्य अपने पशु मित्रों को अपना राजदार (विश्वस्त) बना लें।
६—और पशु भी अपने भेद अपने मनुष्य मित्रों से कह सकेंगे, आदि।

समस्याएं—

१—यदि मनुष्य पक्षियों की भांति उड़ने लगे तो क्या होगा ?

२—यदि आपके विद्यालय में पहिये लग जायें तो क्या होगा ?

३—यदि मनुष्य को खाने की आवश्यकता न रहे तो क्या होगा ?

कार्य (२)

वस्तुओं के नये-नये प्रयोग

निर्देश :—

(१) इस कार्य में नीचे तीन वस्तुओ के नाम दिये गये हैं जिनको कई नये और विभिन्न तरीकों से प्रयोग किया जा सकता है। आपको इनमें से प्रत्येक के नये-नये, विचित्र तथा रोचक प्रयोग अधिक से अधिक संख्या में लिखने है। प्रयोग साधारण हो या असाधारण आप सबको लिखिए। यदि आप नये-नये और असाधारण प्रयोग जिन्हें आपके साथी आसानी से नहीं सोच सकते, लिखेंगे तो उससे यह मालूम हो सकेगा कि आप में वस्तुओं को नये ढंग से सोचने की कितनी योग्यता है।

(२) प्रत्येक प्रश्न का उत्तर देना अनिवार्य है।

(३) तीनो वस्तुओं के बारे में लिखने के लिए आपको १२ मिनट का समय दिया जायेगा। जब आप एक वस्तु के प्रयोग लिख चुकें तो तुरन्त दूसरी वस्तु के प्रयोग लिखना आरम्भ कर दीजिए। बीच में या बाद में यदि कोई अन्य नया प्रयोग पहली वस्तु के बारे में याद आ जाय तो उसे भी लिख दीजिए। उत्तर छोटे-छोटे वाक्यों में लिखिए ताकि आप अधिक से अधिक प्रयोग लिख सकें। हर चार मिनट समाप्त होने पर आपको बता दिया जायगा।

(४) जब आपसे कार्य आरम्भ करने के लिए कहा जाय तो तुरन्त आरम्भ कर दीजिए।

नीचे दिये उदाहरण से आपको समझ में आ जायगा कि आपको क्या करना है।

उदाहरण— समाचार पत्र

प्रयोग—(१) समाचार पढ़ने के लिए
(२) धूप से बचने के लिए
(३) बच्चों के खेलने की चीजें बनाने के लिए
(४) लपेटने के लिए
(५) रद्दी कागज जमा करने के लिए
(६) गन्दे स्थान को ढकने के लिए, आदि।

समस्याएं—

१—पत्थर का टुकड़ा

२—लड़की की एक छड़ी

३—पानी

कार्य (३)

नये सम्बन्ध पता लगाना

निर्देश :—

नीचे कुछ शब्दों के जोड़े दिये गये है जो आपस में कई प्रकार से सम्बन्धित हो सकते है। आपको यह सोचना है कि वे कितने प्रकार से आपस में सम्बन्ध रखते हैं। देखने में तो जोड़े के दोनों शब्द अलग-अलग मालूम हो सकते है लेकिन यदि ध्यान से देखा जाय तो नये-नये प्रकार के सम्बन्ध समझ में आ सकते हैं। जितने भी सम्बन्ध आप सोच सकें उन्हें दिये हुए स्थान पर छोटे-छोटे वाक्यों में लिख दीजिए। देखना यह है कि आप कितने अधिक और नवीन सम्बन्ध सोचकर लिख सकते हैं।

आपको इस कार्य के लिए १५ मिनट का समय दिया जायेगा। आपको वस्तुओं के सभी जोड़ों के बारे में विचार लिखने हैं। अतः जहाँ तक सम्भव हो उत्तर शीघ्रता से दीजिए। हर पांच मिनट समाप्त होने पर आपको बता दिया जायेगा।

जब आपसे कार्य आरम्भ करने को कहा जाय तो तुरन्त शुरू कर दीजिए।

नीचे दिए उदाहरण से यह स्पष्ट हो जायेगा कि आपको क्या करना है।

उदाहरण—आदमी और जानवर

उत्तर—(१) आदमी और जानवर दोनों में जीवन होता है।
(२) दोनो को भोजन पानी की आवश्यकता है।
(३) दोनों को रोग हो सकते है।
(४) दोनों को शत्रु का डर रहता है।
(५) दोनों की सर्दी गर्मी का अनुभव होता है।
(६) दोनों अपने रहने की व्यवस्था करते है, आदि।

समस्याएं

१—पेड़ और मकान

२· कुर्सी और सीढ़ी (नसैनी)

३—हवा और पानी।

कार्य (४)

वस्तुओं को मनोरंजक तथा विचित्र बनाना

निर्देश :—

आपने घोड़े का खिलौना तो देखा ही होगा। और जानवरों के भी खिलौने होते है, जिनसे बच्चे बड़ी प्रसन्नता से खेलते हैं। साधारणतया ये खिलौने छोटे आकार के होते है ताकि बच्चे उनसे आसानी से खेल सकें। आप घोड़े के एक सादे खिलौने को ध्यान में रखिये और फिर नीचे आप उन अनोखे तथा मनोरंजक तरीकों को लिखिए जिनके द्वारा आप इस खिलौने मे ऐसे परिवर्तन ला सकें जिनसे बच्चों को इस खिलौने को खेलने में अधिक आनन्द आने लगे। इस बात की परवाह मत कीजिए कि इस प्रकार के परिवर्तन पर क्या लागत आयगी। आपको केवल यह सोचना है कि खिलौने को बच्चों के लिए किस तरह अधिक से अधिक मनोरंजक तथा विचित्र बनाया जा सकता है।

जब आपसे काम आरम्भ करने को कहा जाए तो तुरन्त काम आरम्भ कर दीजिए। आपको इस कार्य के लिए ६ मिनट का समय दिया जायगा।

APPENDIX D

Name ....

Name of College ....

Qualifications..

Experience of Teaching (if any)..

* THE SCIENTIFIC ATTITUDE SCALE *

Dear Pupil Teachers,

You are well aware that there are Positive or Negative opinions about. an object This attitude scale purports to Know your Scientific attitude. Whatever information is given by you will be used for research work only. There fore Kindly give your opinion freely. Please, answer all the questions. There are 36 Statements in it you will agree with some and you may disagree with others. Each statement has 5 options — Strongly Agree (SA), Agree (A) undecided (U), Disagree (D), and strongly Disagree (SD). Put a tick (✓) mark upon one of these ~~two~~ five options which you prefer.

Example—

Science must be taught to all Pupils

SA	A	U	D	SD
✓				

SA — Strongly Agree

A — Agree

U — Undecided

D — Disagree

SD — Strongly Disagree

Item No.	SA	A	UD	D	SD
1. Knowledge is promoted if every new idea in a field is accepted immediately after it is reported.					
2. Whenever there is insufficient evidence either for or against a proposition, the wisest thing is neither to accept it nor to reject it.					
3 Listening to new ideas is a very interesting and pleasing activity.					
4. If one of our idea is poor, we should hold this idea although it is proved to be poor.					
5. Students who are keen to learn new ideas despite their inadequate knowledge are likely to become scientists.					
6. The records of the observations of a scieentist re~~j~~flect the personal feelings of the scientist.					
7. In unscientific discussions one may hear that some one is willing to prove that a certain idea or opinion is absolutely correct.					
8. Experimental testing a new idea is mainly carried out to satisfy the person who first suggested the idea.					
9. Fortune tellers usually flourish in scientific communities.					
10. Knowledge, once accepted, is not subject to change.					
11. Scientific explanations should be preferred to the romantic stories of astrologers and magicians.					
12. Dr. E, a very famous scientist, presented s new theory and Dr. A, a young scientist who had graduated two years before, had some doubts about this theory, Dr. A should accept the theory because it was presented by Dr.E.					
13. People should be willing to change their ideas if enough evidence shows that their ideas are poor.					

	SA	A	UD	D	SD
In interpreting the results of his work, a scientist should not be affected by external social conditions.					
If a new facts agree with some ideas it can be concluded that these ideas are true.					
i. A questioning attitude should dominate the approach to any noval situation.					
7. Explanaticns can only be made if observable data can be collected.					
8. One should not criticize the work of others.					
19. Noval situations which cannot be explained with the existing body of knowledge are undesirable.					
20. Questioning opinions and ideas has nothing to do with scientific behaviour.					
21. One should express one's jugement about new ideas and new discoveries immediately after one learns to them.					
22. Newly descovered ideas should be reported unchanged even if they contradict existing ones.					
23. The editor of a well known journal should not accept poor publication research studies of beginners.					
24. Meteoralogists can predict the weather with high probability.					
25. When traditional beliefs are in conflict with scientific discoverses, it is better to accept the traditional beliefs.					
26; It is worthless to listen to a new idea unless all people accept it.					
27. A successful scientist is more objective then a politician.					
28. Knowledge in a country is promoted if local publications include the writings of famous and unknown writers.					
29. The largest attendance at Cinemas occurs on Saturday evenings and the largest attendence at church occurs on Sunday mornings. whenever there are manypeople watching a film the following day many people should go to Church.					

	SA	A	UD	D	SD
30. Astrology is a science which contributes to the better understanding of people.					
31. Knowledge should be considred tentative.					
32. Seeking further information about a noval situation is considered a sound approach to begin with.					
33. Criticism benefits the advancement of knowledge.					
34. Intelligence is the main factor that contributes to the advance of knowledge.					
35. For weather predictions, magicians and astrologers should be consulted.					
36. Enough evidence supporting a certain idea should be provided before the idea is accepted.					

APPENDIX E

Amidon and Hunder Verbal Interaction Category System (VICS)

TEACHER TALK	Response	1. Accepting feeling 2. (a) Praises (b) Praises using public (c) Praises using private criteria 3. Accepts idea through (a) Description (b) Inference (c) Generalization
		4. Ask questions (a) Cognitive memory questions (b) Converget questions (c) Divergent questions (d) Evaluative questions
	Initiation	5. Lecturing 6. Give direction 7. (a) Criticises (b) Criticises using public criteria (c) Criticoses using private criteria
PUPIL TALK	Response	8. Pupil response (a) Description (b) Inference (c) Generalisation
	Initiation	9. Pupil initiation (a) Description (b) Inference (c) Generalisation
		10. (a) Silence (b) Confusion

APPENDIX F

Name :
College :
Qualifications :
Experience of Teaching(if any)
Subject
Topic
Date

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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Name :

College :

Qualifications :

Experience of
Teaching(if any)

Subject

Topic

Date

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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20																				

APPENDIX G

Variables with Abbreviations

Var.No.	Name of variable	Abbreviation
1.	Piagetian Logical Operation(Total)	-
2.	Classification Operation	-
3.	Seriation Operation	-
4.	Logical Multiplication Operation	-
5.	Compensation Operation	-
6.	Proportional Thinking Operation	-
7.	Probability Operation	-
8.	Correlational Thinking	-
9.	Scientific Attitude (Total)	-
10.	Rationality	-
11.	Curiosity	-
12.	Open-mindedness	-
13.	Aversion to Superstitions	-
14.	Objectivity	-
15.	Suspended judgement	-
16.	Verbal Creativity (Total)	-
17.	Fluency	-
18.	Flexibility	-
19.	Originality	-
20.	Teacher Talk	TT
21.	Indirect Teacher Talk	ITT
22.	Direct Teacher Talk	DTT
23.	Pupil Talk or Student Talk	PT or ST
24.	Silence or Confusion	S/C
25.	Indirect to Direct Ratio	I/D
26.	Small indirect to direct Ratio	i/d
27.	Pupil Initiation Ratio	PIR

Contd.

Var.No.	Name of variable	Abbreviation
28.	Teacher Response Ratio	TRR
29.	Teacher Question Ratio	TQR
30.	Content Cross Ratio	CCR
31.	Categories of Logical Operation	
	(a) Concrete	CON
	(b) Transitional	TRA
	(c) Formal	FOR
32.	Categories of Scientific Attitude	
	(a) High Scientific Attitude	HSA
	(b) Average Scientific Attitude	ASA
	(c) Low Scientific Attitude	LSA
33.	Categories of Verbal Creativity	
	(a) High Creative	HCR
	(b) Average Creative	ACR
	(c) Low Creative	LCR
34.	(a) Male	M
	(b) Female	F

S. No.									V				A			R					I			A			B		L		E		S
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	07	2	1	4	0	0	0	0	130	30	16	22	19	16	27	135	41	44	50	58	31	27	23	19	01	01	08	085	055	49	CON	ASA	ACR	M
2	10	1	1	4	4	0	0	0	130	24	21	25	16	15	29	164	58	56	50	33	27	06	12	55	04	06	06	085	081	26	CON	ASA	ACR	F
3	12	2	2	4	0	0	0	4	132	28	18	21	16	24	25	158	60	56	42	49	29	20	10	41	02	04	00	079	048	30	CON	ASA	ACR	F
4	12	2	1	0	2	0	0	4	136	25	21	26	17	19	28	144	60	62	42	64	12	52	05	31	00	00	24	000	021	58	CON	HSA	ACR	M
5	10	1	0	2	0	3	0	4	130	28	16	23	13	23	27	166	46	40	40	40	34	06	16	44	06	19	00	095	083	30	CON	ASA	HCR	F
6	10	2	2	2	0	0	0	4	128	25	18	19	22	21	23	127	42	45	40	79	22	57	09	13	00	10	11	091	025	76	CON	ASA	LCR	M
7	11	2	1	2	0	6	0	0	130	26	13	24	17	19	25	203	75	69	59	36	25	13	23	41	02	01	08	038	066	34	CON	ASA	HCR	M
8	07	0	1	0	0	6	0	0	125	25	19	20	16	16	29	150	53	53	44	58	25	33	12	29	01	04	04	078	039	52	CON	ASA	MCR	F
9	12	2	0	0	0	6	0	4	125	25	17	24	16	20	23	184	65	60	59	73	32	41	21	05	01	00	01	022	048	62	CON	ASA	HCR	F
10	07	2	0	2	0	3	0	0	122	22	15	23	16	20	26	140	45	47	48	35	26	09	12	53	03	00	04	019	085	29	CON	LSA	ACR	F
11	12	0	2	0	4	6	0	0	132	31	15	25	16	16	29	141	46	45	50	59	17	42	19	22	00	00	28	000	031	55	CON	ASA	ACR	M
12	11	2	1	2	0	3	3	0	126	22	23	22	16	18	25	144	49	47	48	32	01	24	08	61	00	01	17	038	024	28	CON	ASA	ACR	F
13	10	2	0	2	0	6	0	0	120	22	16	19	19	21	23	133	47	40	48	51	21	30	20	30	01	01	01	047	040	46	CON	LSA	LCR	M
14	11	1	0	0	0	6	0	4	116	23	14	18	20	16	25	128	40	42	46	50	23	27	21	30	01	01	04	058	045	45	CON	LSA	LCR	M
15	08	0	0	0	2	6	0	0	149	27	19	29	20	26	28	115	35	36	44	47	18	29	14	38	01	14	02	093	033	44	CON	HSA	LCR	F
16	12	0	0	2	0	6	0	4	148	27	21	26	25	18	31	160	49	50	61	46	22	24	18	36	01	03	04	074	044	39	CON	HSA	ACR	F
17	10	2	1	0	0	0	3	4	128	23	22	19	17	20	27	133	45	40	48	59	28	31	14	28	01	05	00	084	035	44	CON	ASA	LCR	M
18	11	1	2	2	0	6	0	0	101	20	15	13	16	20	17	094	29	29	36	64	21	43	14	23	01	04	09	078	025	55	CON	LSA	LCR	M
19	10	0	0	0	0	6	0	4	137	27	17	29	16	21	28	158	46	47	65	61	08	53	06	33	00	00	35	000	014	57	CON	HSA	ACR	M

S. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
20	08	2	0	2	0	0	0	4	125	23	15	23	19	18	27	199	57	58	84	49	34	15	21	31	02	21	00	095	063	38	CON	ASA	HCR	M
21	12	1	0	2	0	3	6	0	117	24	15	18	15	19	26	164	40	40	48	46	26	20	25	29	01	05	00	082	053	42	CON	LSA	ACR	F
22	10	1	0	2	0	3	0	4	135	27	17	27	21	19	24	160	54	62	44	33	29	04	16	52	07	03	02	075	090	28	CON	HSA	ACR	M
23	11	2	0	2	4	3	0	0	143	28	18	26	21	25	25	136	45	49	42	61	37	24	23	17	02	09	01	090	056	51	CON	HSA	ACR	F
24	12	2	0	2	4	0	0	4	138	25	18	25	20	19	31	189	66	67	56	77	23	54	14	09	00	01	07	095	026	72	CON	HSA	HCR	F
25	10	2	2	2	0	0	0	4	133	29	17	23	16	21	27	167	58	50	59	43	20	23	21	36	01	02	08	063	046	41	CON	ASA	HCR	F
26	10	1	0	2	0	3	0	4	148	28	21	26	21	25	27	137	48	45	44	58	24	34	16	26	01	04	03	081	038	53	CON	HSA	ACR	F
27	07	[illegible]	0	2	0	3	0	0	129	23	16	20	19	21	30	144	49	49	46	68	30	38	27	05	01	00	00	029	046	61	CON	ASA	ACR	M
28	10	1	1	4	4	0	0	0	126	22	23	22	16	18	25	172	62	62	48	38	24	14	20	41	02	01	01	035	068	33	CON	ASA	HCR	F
29	08	2	2	2	0	0	0	4	126	28	14	23	18	17	26	165	53	56	56	57	18	39	19	24	01	00	16	000	032	55	CON	ASA	HCR	F
30	07	2	1	4	0	0	0	0	116	23	14	18	20	16	25	163	48	56	59	48	22	26	21	31	01	06	00	086	043	55	CON	LSA	ACR	F
31	11	2	1	2	0	6	0	0	128	23	22	19	17	20	27	158	42	44	52	48	25	23	17	35	01	03	00	072	050	44	CON	ASA	ACR	F
32	22	2	0	4	0	6	6	4	152	31	25	26	17	18	35	163	53	60	50	73	43	30	21	06	01	02	06	062	058	59	TRA	HSA	ACR	F
33	15	2	0	4	2	3	0	4	147	28	23	22	17	25	32	149	50	52	47	43	38	05	18	40	07	04	00	080	089	37	TRA	HSA	ACR	F
34	20	2	1	4	0	6	3	4	129	24	20	19	20	16	30	137	40	43	54	37	31	06	20	44	05	04	11	079	087	21	TRA	ASA	ACR	M
35	20	2	0	4	0	6	0	8	128	26	18	21	16	19	28	141	48	50	43	31	24	07	11	58	04	01	07	035	092	23	TRA	ASA	ACR	F
36	20	1	1	4	0	6	0	8	136	31	19	17	23	22	24	146	42	50	54	67	35	32	26	08	01	01	19	056	051	59	TRA	HSA	ACR	F
37	17	2	1	4	0	6	0	4	130	19	18	24	22	21	26	121	36	38	47	50	43	07	22	28	06	03	02	076	092	33	TRA	ASA	LCR	F
38	17	2	1	2	2	6	0	4	148	32	21	22	20	22	31	204	69	67	68	42	27	15	12	46	01	03	00	072	058	25	TRA	HSA	HCR	M

5. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
39	23	2	1	4	2	6	0	8	139	30	16	26	17	20	30	168	63	62	43	21	13	08	08	71	02	01	13	053	066	17	TRA	HSA	HCR	M
40	20	2	1	4	0	3	3	4	128	27	16	22	17	21	25	197	60	65	72	44	40	04	18	38	09	03	00	072	094	36	TRA	ASA	HCR	F
41	19	2	1	4	2	6	0	4	130	25	18	17	19	23	28	173	52	60	61	36	32	04	13	51	09	03	00	071	093	31	TRA	ASA	HCR	F
42	19	2	0	4	0	3	6	4	108	24	11	18	12	20	23	179	50	67	63	64	24	04	13	23	01	01	04	043	073	62	TRA	LSA	HCR	M
43	21	2	1	4	2	6	6	0	134	28	16	23	20	23	24	171	52	58	61	25	16	09	11	64	02	02	02	100	063	25	TRA	ASA	HCR	M
44	19	2	1	0	0	6	6	4	122	28	16	16	17	19	26	190	57	65	68	56	18	38	15	29	01	04	00	078	030	54	TRA	LSA	HCR	M
45	22	0	0	2	4	6	6	4	140	26	19	24	18	25	28	165	55	58	52	47	28	19	20	33	02	04	00	079	059	43	TRA	HSA	ACR	M
46	17	2	1	2	2	6	0	4	119	25	18	22	15	16	23	179	58	61	52	62	31	31	14	24	01	02	00	069	047	53	TRA	LSA	HCR	M
47	22	2	0	4	0	6	6	4	142	27	17	20	20	25	33	186	53	58	75	53	17	36	13	35	01	02	12	100	032	52	TRA	HSA	HCR	M
48	15	0	1	4	0	6	0	4	122	28	18	17	16	18	25	158	52	50	56	55	21	35	09	36	01	00	00	017	040	48	TRA	LSA	ACR	M
49	22	2	1	4	2	3	6	4	129	24	20	22	17	18	28	187	61	60	66	30	23	07	27	43	03	01	01	036	087	24	TRA	ASA	HCR	M
50	19	2	1	4	0	6	6	8	137	25	17	24	17	26	26	160	63	47	50	41	09	32	06	53	00	01	00	050	021	39	TRA	HSA	ACR	M
51	23	2	0	4	4	6	3	4	129	27	19	18	20	22	23	133	45	43	45	28	17	11	11	54	02	03	07	071	067	23	TRA	ACR	LCR	F
52	20	2	0	2	4	6	6	0	120	24	19	21	17	19	20	131	43	43	45	74	25	49	14	11	01	00	11	030	034	72	TRA	LSA	LCR	M
53	14	0	1	0	0	6	3	4	124	26	16	25	18	13	26	127	39	41	47	41	18	23	10	48	01	00	00	029	047	32	TRA	LSA	LCR	M
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55	18	2	0	4	0	6	6	0	125	26	16	17	19	21	26	136	48	45	43	33	18	15	10	56	01	00	07	023	097	15	TRA	ASA	ACR	M
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63	23	2	1	4	0	6	6	4	133	28	22	24	17	17	25	169	60	62	47	50	23	27	17	34	01	00	22	021	049	43	TRA	ASA	HCR	M
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70	20	2	0	2	4	6	6	0	149	27	19	30	19	25	29	154	57	54	43	47	29	18	19	35	20	01	01	055	062	41	TRA	HSA	ACR	M
71	18	2	2	2	2	3	3	4	116	26	17	18	16	19	20	140	47	41	52	56	29	27	17	28	01	01	03	066	050	48	TRA	LSA	ACR	M
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73	15	2	2	2	0	6	3	0	133	24	19	22	16	22	34	114	31	36	47	58	40	18	25	17	02	01	00	056	071	52	TRA	ASA	LCR	F
74	15	0	1	2	2	6	0	4	100	17	17	16	12	13	25	146	55	41	58	52	35	18	25	23	02	01	01	055	068	47	TRA	LSA	ACR	M
75	15	2	1	4	2	6	0	0	138	26	23	25	19	21	24	146	49	45	52	51	22	29	17	32	01	01	13	042	043	45	TRA	HSA	ACR	M
76	20	2	0	2	0	6	6	4	144	26	21	21	20	25	31	141	55	50	36	36	32	04	27	37	09	06	02	085	092	30	TRA	HSA	ACR	M

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79	17	1	0	2	4	0	6	4	132	22	20	23	19	19	29	162	60	50	52	37	35	02	17	47	23	02	00	028	100	23	TRA	ASA	ACR	F
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82	19	2	1	4	2	0	6	4	127	27	15	23	18	21	23	124	50	47	45	44	30	14	21	35	02	01	05	053	069	40	TRA	ASA	ACR	F
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86	22	2	2	2	0	6	6	4	125	25	17	24	16	20	23	133	43	38	52	47	31	16	28	25	02	01	06	051	070	36	TRA	ASA	LCR	F
87	19	2	1	2	0	6	0	8	132	29	18	20	18	20	27	158	56	52	50	65	23	43	12	22	01	00	04	019	037	58	TRA	ASA	ACR	M
88	16	2	2	2	2	6	0	4	135	27	18	23	20	23	24	112	39	43	30	53	18	35	15	32	01	04	12	100	031	52	TRA	ASA	LCR	F
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90	22	2	2	4	0	6	0	8	142	28	20	25	22	21	26	142	45	41	56	51	28	23	19	31	01	04	00	078	054	46	TRA	HSA	ACR	F
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92	17	2	1	2	2	6	0	4	120	22	16	19	19	21	23	166	58	50	58	49	35	14	17	34	02	04	02	080	066	39	TRA	LSA	HCR	M
93	17	2	0	2	0	6	5	4	149	27	19	30	19	25	29	160	61	54	45	56	40	16	20	24	02	03	[illegible]	071	071	47	TRA	HSA	ACR	M
94	19	2	1	0	0	6	6	4	148	27	19	29	19	26	28	142	49	43	50	47	23	24	14	36	01	02	[illegible]	069	039	34	TRA	HSA	ACR	F
95	19	2	1	4	0	6	6	0	120	24	17	19	17	20	23	128	49	43	36	54	42	12	22	24	04	03	[illegible]	074	080	36	TRA	LSA	LCR	M
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98	26	2	0	4	0	6	6	8	115	26	16	20	11	20	22	129	46	41	43	47	11	36	07	47	00	02	22	063	017	41	FOR	LSA	LCR	M
99	26	2	0	4	0	6	6	8	142	29	19	24	21	16	33	153	52	43	58	56	19	37	07	37	01	01	07	052	030	49	FOR	HSA	ACR	F
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104	25	2	1	4	2	6	6	4	137	21	20	21	25	23	27	112	36	36	40	43	29	14	09	49	02	02	12	062	069	29	FOR	HSA	LCR	M
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105	27	2	1	4	4	6	5	4	117	22	14	18	17	24	22	125	43	38	44	81	26	55	18	01	01	00	04	013	033	77	FOR	LSA	LCR	M
107	28	2	1	4	4	5	3	8	132	29	18	20	18	20	27	144	49	45	60	67	34	33	14	19	01	01	00	041	051	60	FOR	ASA	ACR	F
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109	26	2	1	2	4	6	3	8	116	19	19	23	17	19	19	105	36	36	33	55	23	33	13	32	01	01	04	055	041	50	FOR	LSA	LCR	F
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111	26	2	2	4	2	6	6	4	130	24	19	23	17	16	31	171	64	56	51	49	33	16	34	18	02	01	06	036	083	32	FOR	ASA	HCR	M
112	26	2	2	2	0	6	5	0	120	24	17	19	17	20	23	168	49	51	68	52	27	25	39	09	01	00	00	026	368	32	FOR	LSA	HCR	M
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114	25	2	1	4	2	6	6	4	127	24	21	20	19	20	23	123	58	40	44	49	31	19	35	15	02	01	07	038	077	31	FOR	ASA	LCR	M
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118	27	2	1	4	4	5	6	4	118	20	18	23	17	17	23	168	50	56	62	50	33	17	17	33	02	27	06	100	060	43	FOR	LSA	HCR	[illegible]
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